EDITORIAL

NOW is the time to renew your membership in the American Red Cross.

TO many of our citizens, the all-important question is 'Will the treaty be ratified before January 16?'

AN interesting side-light on the steel strike is furnished by the public statement of one of the leaders at Gary that the strike there has been lost, and that the Army was responsible. Since it is generally admitted that all the Army did was to preserve order impartially and to arrest the promoters of disorder, the inference is that such a course made the success of the strike impossible.

LIMITATION of apprenticeship as a result of union regulations is commonly blamed for the lack of really skilled workmen in this country. In this connection the United States Department of Labor has recently completed a study of 646 foundries employing 14,462 journeymen. In these foundries only 1096 apprentices were employed, about one-third of the number that would have been allowed by union regulations. Evidently, in these plants at least, conditions other than this particular union rule must be blamed for the small number of apprentices.

IT took the War to awaken the public to the importance of the American Red Cross. Now that the War is over except in name, and we hope soon will be in name also, the fact that the peace-time activities of the Red Cross are not so spectacular as its activities during the War should not blind us to the importance of the former. Irrespective of such emergencies as the influenza epidemic of last year, there is the tremendous task of combatting the many causes that make for sickness throughout the country and the resulting inefficiency, as well as death. Membership in the Red Cross became a habit during the War; let us not get out of the habit in time of peace.

GRAPHITE is one of the few substances of which it can be said that the American product is inferior to the imported. Furthermore, the domestic production is not sufficient to supply the demand from the industries that can use the lower-grade material to advantage. For foundry facings and for crucibles the imported product is much better than the domestic. Nevertheless a bill is now under consideration by Congress placing a tariff on graphite and plumbago that would if passed materially increase the cost of both foundry facings and crucibles. Foundrymen and others interested should give this matter their attention.

A RECENTLY-FORMED society, the Accountants Association of San Francisco, includes among its activities a form of co-operation that might well be imitated by similar organizations. This is a special department before which the sellers of office supplies and appliances may demonstrate their wares. In this way the members of this association will be able to pool their special knowledge of such equipment for the benefit of all concerned. The reports of such a department on a given appliance should necessarily deal with facts rather than opinions and avoid attempting to advise a member regarding a specific purpose. With this reservation, a department of this kind in almost any business organization could be of great value to both buyer and seller of all supplies.

A call for a conference of union labor leaders at Washington on December 13 has been issued by the members of the executive council of the American Federation of Labor and the chiefs of the railroad brotherhoods. No specific topics for discussion are mentioned in the call, but it is understood that the anti-strike regulation in the Cummins railroad bill is to be one of the principal topics. Collective bargaining and particularly the right of organized labor to choose its own representatives will also be discussed. Representatives of farmers' organizations in Washington at the time of the call are understood to have approved the conference, although they did not sign the call, and delegates from the farmers are expected at the meeting. Just where the farmers come in is not apparent to the outsider, but it will doubtless appear in time. The labor leaders may not realize it, but this conference furnishes a fine opportunity for discussing ways and means of ridding their organizations of the Bolshevik members that have been the worst pest of the unions as well as of the general public during the past few years.

REDUCTION of accidents in American industry is a laudable ambition, and one well worth all the efforts now being made toward that end. Yet the total number of deaths from accident is small compared with the number from disease. Considering even the non-fatal accidents, statistics compiled by the United States Department of Labor show that 22.54% of the idleness among certain workmen was caused by sickness, while only 1.66% of the idleness was caused by accidents. On this basis, we would be justified in incurring 13 times the trouble and expense devoted to the prevention of accidents in endeavors to preserve health. It is particularly for this reason that we commend to our readers Dr. Darlington's article in this issue on 'The Relation of Health to Work'.

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The Peace Treaty

During Mr. Henry Ford's recent unsuccessful campaign for the United States Senate, some one suggested that, if elected, he could improve the methods of doing business by that honorable body through the application of some of the celebrated efficiency stop-watch systems of the Ford factory. However, anyone that has followed the debate on the ratification of the treaty with Germany, will be convinced that a perpetual calendar, not a stop-watch, is the proper instrument for recording the Senate's progress. Nevertheless, all the textual amendments proposed have been defeated, and the way seems now to be clear for ratification, perhaps with a few foolish and useless reservations, but nevertheless ratification that will not compel re-submission to the other Powers. No one claims that either the treaty itself or the League of Nations are perfect, but they are the best we can get, and mark a distinct advance over anything the world has known heretofore. Europe wants peace and America wants peace, and we do not believe that as many as 33 Senators will be found that will dare to oppose that desire.

The Industrial Conference

Those who have confidence in the efficacy of the guiding hand of government in business affairs are not likely to feel encouraged by events at Washington during the past few months. Last spring the Price-Fixing Board failed completely, and now the Industrial Conference has split and foundered on the rock of a definition of collective bargaining. The odds against the success of the Conference were too great. First, there was the rule that each division of the conference, capital, labor, and the public, should vote as a body. These men were rightly selected to represent various interests, but once selected, they should have acted and voted as individuals. The rule adopted merely intensified the lines of cleavage that the conference was called to bridge. Again, whether the members wished it or not, the shadow of the steel strike lay across the conference-room. During the discussion of collective bargaining that finally broke up the conference, in the mind of each delegate was the question "How is my action on this point going to affect the status of the steel strike?" The representatives of capital felt unwilling to endorse any resolution that might be construed into a condemnation of Judge Gary's refusal to meet the unions' committee, while the representatives of labor felt unwilling to endorse any wording that might be construed as approving it. The result was the usual one when a general statement is prepared with a particular case in view. In placing the direct personal blame for the failure, however, it should not all be apportioned to either side. A little more of a conciliatory spirit on the employers' side might have made it possible to draft a resolution that could be endorsed by all sides. We know that some of the employers' representatives thought so. However, the labor delegates by refusing to play when the rest of the conference would not play their way, actually broke up the conference. Had they remained, protesting it may be, their final position and the position of the unions they represented would have been much better in the eyes of the general public.

The Steel Strike

While the leaders of the steel strike do not admit defeat, nevertheless, a survey of the situation six weeks after the strike was called indicates that any other outcome is highly improbable. The statistics of pig-iron production for October are not available at the time of going to press. Those for September showed 163 furnaces in blast at the end of the month, the smallest number since December 1914, as compared with 266 furnaces at the end of August. Production was considerably reduced in every important district except Birmingham. Total production for September was 2,402,011 tons as compared with 2,742,081 tons in August, but the average production per day was greater in September than in May, June, or July. Assuming that the furnaces worked practically at the August rate during the first three weeks of September, it appears that the first effect of the strike was to cut the output of pig-iron approximately in half. During October, however, many furnaces have resumed operations and the same is true of rolling-mills and other steel plants. The October production in most lines will be considerably reduced, but that is far from meaning success to the strikers. There has been much disorder, particularly at Gary, where the Federal troops are now sitting on the lid with excellent results. Testimony before the Senate investigating committee, as well as various occurrences in the mill towns, seems to indicate the Bolshevist animus among many of the rank and file, if not the leaders, of the strikers. One of the worst features of a strike of this kind is that improvement of working conditions, which is doubtless needed in many steel-plants, will hereafter be much harder to attain than if the strike had not been called.

Threatened Coal Strike

At the time of going to press, all efforts to avert the threatened strike in the bituminous-coal districts throughout the United States appear to have failed. The direct effect on the Pacific Coast and in California in particular, because of the general use of oil fuel and hydro-electric power, will not be so great as in other parts of the country, where it is difficult adequately to conceive of the extent of the calamity that would follow any long-continued strike at the unionized mines. However, we believe that production, while it will undoubtedly be seriously reduced if the strike is called, will be maintained in greater measure than the union officials expect. While President Wilson's statement was neces-

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sarily couched in general terms, no other conclusion is possible than that order will be maintained in the mining districts, by the Federal authorities if necessary. If this is done, work can be continued at the mines, although it will be, at least at first, with a greatly reduced force. Assured of protection for themselves and their families, many men will continue to work. Experience during the steel strike has given fresh reason to expect this to occur. Intimidation is the only way to win a strike called because of trivial grievances or with no just grievances at all, and this is particularly true for strikes called without the taking of a vote among the members of the union. The coal strike, if called, will lose, as it deserves to do.

When the Boss Strikes

In the discussion of employers' strikes present and to come, another strike movement seems to have been practically ignored, namely, strikes by the boss. During the War, and in many industries for a considerable time thereafter, the demand for production was so insistent that the boss could simply add increase of labor cost to the selling price and go his way. The temptation thus to follow the line of least resistance, irrespective of possible disaster, was too great for many employers to resist. Nowadays, however, the prevailing industrial unrest has extended even to the downtrodden bosses, and their strikes, although unaccompanied by parades and banners, are none the less deserving of study. For purposes of this study, bosses may be divided into three classes, namely, bosses that devote money to the business and little or nothing else, bosses that devote much time and ability to the business and whose money investment is relatively small, and, finally, bosses whose investment of both money and time is considerable. The first class comprises the purchasers, small and large, of industrial securities. This class supplies most of the funds for plant extensions and for new enterprises. In normal times, the rate of return on such investments is sufficiently high to compensate for the risk involved. When it is not, these investors buy Liberty Bonds or similar securities where the return is more secure than from industrial stocks, and industry and the worker suffer. The third class comprises the owners and operators of the large industrial plants of the country. These men lose more by striking than the bosses of the first class, since their principal funds are already tied up in the business, and seldom can be diverted to other channels. But when plants are run at a loss or at only a small profit, these bosses will also strike, and the effect upon industry, the worker, and even upon the general public is widespread. The second class comprises the men with some capital and the ability to run a business of their own, who, in times past, have been willing to meet the many difficulties that the employer knows and the employee knows not, because of the greater reward as compared with working for wages. Nowadays such men frequently find that they can make more money with less work and much less worry by working for wages than by working for themselves. Few of us realize how many such men there are at the present time. Each one, because his initiative and business ability are not fully utilized, represents an economic loss to industry, to the public, and even, in the long run, to the workman that never has been, and never will be able to make a living except by working for wages. Yet can you blame the other man for refusing to take risks without the hope of reward? Each one of the strikes outlined above is in progress at the present time, and each one is increasing in volume. They are the direct result of the demand by labor for more than a fair share of the profits of industry. Labor must learn that real wages, as expressed in purchasing power, are determined by economic conditions, not by desire or force, and that the employer must receive at least a little more than a dollar before he can pay a dollar to the employee.

The Shipyard Strike

The strike involving shipyards and other metal-working plants in the Bay district seems to be no nearer settlement than when it was called a month ago. The shipyards are closed even to the dismissal of a large part of the office forces. It is generally admitted that, whatever the conditions may be under which they ultimately reopen, it will be with greatly reduced operations and a greatly reduced force. The situation in the so-called 'outside shops' is more complex. The open shops are working as usual, and report no difficulty in getting all the men they want. This includes many of the automobile-repair shops, as well as several large plants in other lines, most of these in the East Bay district. A number of shops, most of them relatively small, were paying many men eight cents an hour or more above the old scale before the strike. The general reduction in work because of the strike would have compelled them to reduce forces irrespective of any action the unions might take regarding their individual shops. This reduction has been made by dismissing all employees that were not getting as much as the new scale, thus technically complying with the union demand without actually raising wages. A few shops have raised wages in accordance with the new scale. Outside of the above exceptions, the outside shops are as tightly closed as the shipyards. The effect of the strike so far has been actually to decrease wages in some instances as a result of reducing the number of jobs available. Men that have been employed in the yards and shops now closed are leaving the district in large numbers daily. At Seattle, both yards and outside shops are paying the increased scale. At Tacoma, the outside shops have agreed to the raise, but the shipyards are closed. As will be remembered, the Portland and Los Angeles districts were not represented when the agreement was drafted last August. At Portland, all the yards and most of the outside shops are paying the increase. In the Los Angeles district, neither the ship-

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yards nor the shops are paying the increase. The yards are continuing to work, but with reduced forces, while the shops, which have been 'open' right along, have been practically unaffected. A feature of the strike in this district has been the decision of employers at San Pedro, which has been the only union town in Los Angeles county, to operate open-shop hereafter.

The Limit—and Going Beyond It

This is not a muck-raking editorial. We believe in and affirm the right of the workman to organize, and we recognize that even strikes are sometimes justified as a court of last resort in the absence of some better way to settle industrial disputes. We believe one of the worst things that can happen to any industry or community is to have an abundant supply of poorly-paid labor.

Employers and employees are both human, and the reactionaries in one class are as bad for industry as the radicals of the other. Many an employer, forced by competition to pay a relatively low scale of wages, has been actually glad when the labor union forced a general increase of pay for the entire industry. Such an increase has frequently bettered the condition of the unorganized as well as the organized worker.

It would be unreasonable to expect that an organization of workers any more than any other organization should develop without making mistakes, but that the unions in general should permit themselves to be made the tools of the radicals now in the saddle is a surprise alike to friend and foe of organized labor. The successes of organized labor during the War were not so much because of the justice of the demands made, as because of the necessity for industrial peace and the maximum of production during the emergency. Drunk with a sense of power, a relatively small number of radicals are now engaged in sacrificing the ultimate good of the great body of organized and unorganized labor for the success of the moment, and the more conservative and far-seeing leaders feel compelled to follow rather than to lead in order to keep a semblance of control. Time after time, unions have refused to be governed by their own rules. Strikes have been called without sanction; agreements have been violated; and demands are made not because they are right but because it is believed that necessity will compel their being granted.

The prosperity of industry is as much the concern of Labor as it is of Capital, and demands should be based not merely on the desire for higher wages and shorter hours, but also on the capacity of industry to meet the demands and live. It is no use to specify ideal wages and working conditions if no employers are left to pay those wages or if no plants remain open in which to work. When the cost of production in a shipyard, for instance, becomes too great to permit competition with other industrial centres, then that shipyard must close, and in place of thousands of men, only hundreds will be employed. An industrial concern cannot long continue to operate at a loss, any more than a quart can be obtained from a pint bottle. Whether or not Pacific Coast shipyards can pay higher wages than Eastern yards and still get business is a question we are not in a position to answer. But the unions affected should have made every effort to determine the correct answer to this question before they took steps that seem likely to destroy an industry and the jobs of thousands of their members.

Without discussing the question whether or not restriction of output is encouraged by union leaders, we would suggest a comparison between, say, the number of molding-machines in open-shop and in closed-shop foundries in this territory, and also the output per man on similar work on the machines in the closed and the open shops. Yet history shows that labor-saving machinery, if it is given a chance, by reducing costs and thus increasing demand, increases the ultimate number of jobs available. Compare the equipment for freight-handling at a port where the union influence is strong with one where it is weak. In reality, such equipment lowers costs and attracts ships to that port, which, in the end, increases the amount of work for stevedores. Again, manufacturers say that they find it difficult to obtain spur-track permits in a city where the union vote is an important factor. Yet more spur-tracks would bring more industries, and this in turn give more work to teamsters. Such restriction of output, direct and indirect, has caused more employers to fight unions than any other one thing. Many proprietors of non-union plants state that their objection to unions is not high wages, but rather curtailed production and the uncertainty of industrial peace.

Perhaps the most serious aspect of present-day unionism is the way it is being used by anarchist and semi-anarchist agitators, foreign, hyphenated, and domestic to further their own ends. The Mooney affair, the Irish agitation, and the demand for the repeal of the anti-syndicalist law and for the release of so-called political prisoners are all cases in point. Every few days we hear of occurrences like the refusal of the Seattle longshoremen's union to handle munition for Russia to be used against the Bolshevists, where the union men are seen to be playing the reds' game for them. The unions are young and are working under a tremendous handicap from the very nature of their membership. The better element in the unions must realize their responsibilty and clean out the un-American influence, if the unions are to survive.

The public has had enough of strikes. It realizes that the curtailed production caused by the labor unrest has had much to do with the increased cost of living. Should a coal famine or transportation tie-up threaten the masses of the people in the face of the President's request for an industrial armistice, the measures taken by the Government to relieve the situation are likely to cause a serious reverse to unionism. This country is tired of being forced and the feeling of the public is, "If the worst is to come, let it come now and have it over".

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INTERIOR OF HEAT TREATING DEPARTMENT AT PLANT OF HOLT MANUFACTURING COMPANY

Heat Treating at the Holt Plant

By J. W. Cook

MANY parts for 'Caterpillar' tractors are of mild steel casehardened. Most of these are quenched only once, but others, such as wrist-pins, are given a double heat treatment and quenching. This article describes the general heat-treating practice at the Holt plant at Stockton. Mr. Cook is foreman of the heat treating department.

Since high-carbon steels have proved to be unsuitable for gears, pins, shafts, and other parts subjected to continued wear and shock, the automobile and tractor industry has created a demand for parts having a hard wearing surface and, at the same time, toughness enough to withstand sudden shock. The use of casehardened mild steel has solved this problem, for by employing mild steel low in carbon and manganese, a finished article can be casehardened and a hardened skin of any depth produced, leaving the centre or core in its original form, insofar as ductility is concerned, the centre thus acting as a cushion or brace to the hardened outer surface.

'Caterpillar' tractor parts possess these features. All cut gears, track-pins, gudgeons, spacing-blocks, thrust-bearing washers, wrist-pins, and, in fact, all parts subjected to heavy wear and to shock are casehardened and heat-treated according to the amount of resistance expected of them. 'Caterpillar' tractor parts requiring these properties are mostly made of mild steel, showing, on analysis, carbon 0.10% to 0.30%, manganese 0.20% to 0.40%, phosphorus and sulphur, maximum for each 0.045%.

While casehardening is neither necessary nor advisable for all the parts used in the construction of the 'Caterpillar' tractor, it is required for a great many. These range in size from pins $\frac{3}{16}$ in. diam. weighing only 0.025 lb. to gears weighing as much as 196 lb. each. Other parts that require special treatment are the track links of manganese steel, the crankshaft of nickel-chromium, and a few small parts of nickel steel.

The casehardening department of the Holt plant at Stockton ranks among the largest, if not the largest, on the Coast. There are four casehardening furnaces of Holt design, giving all told a heating area of 240 sq. ft. Each furnace is equipped with a Bristol pyrometer and recorder for temperature control. The furnaces are of the under-fired muffle design, burning crude oil atomized by compressed air. Including carbonizing and reheating, 57 gal. of oil are used for each 2000 lb. of finished work (average based on records for six months).

The carbonizing boxes are made of either cast-iron or cast-steel in various sizes in order to handle the work properly. The cast-steel boxes give an average of 275 to 300 heat-hours of service, and the cast-iron from 180 to 190 heat-hours.

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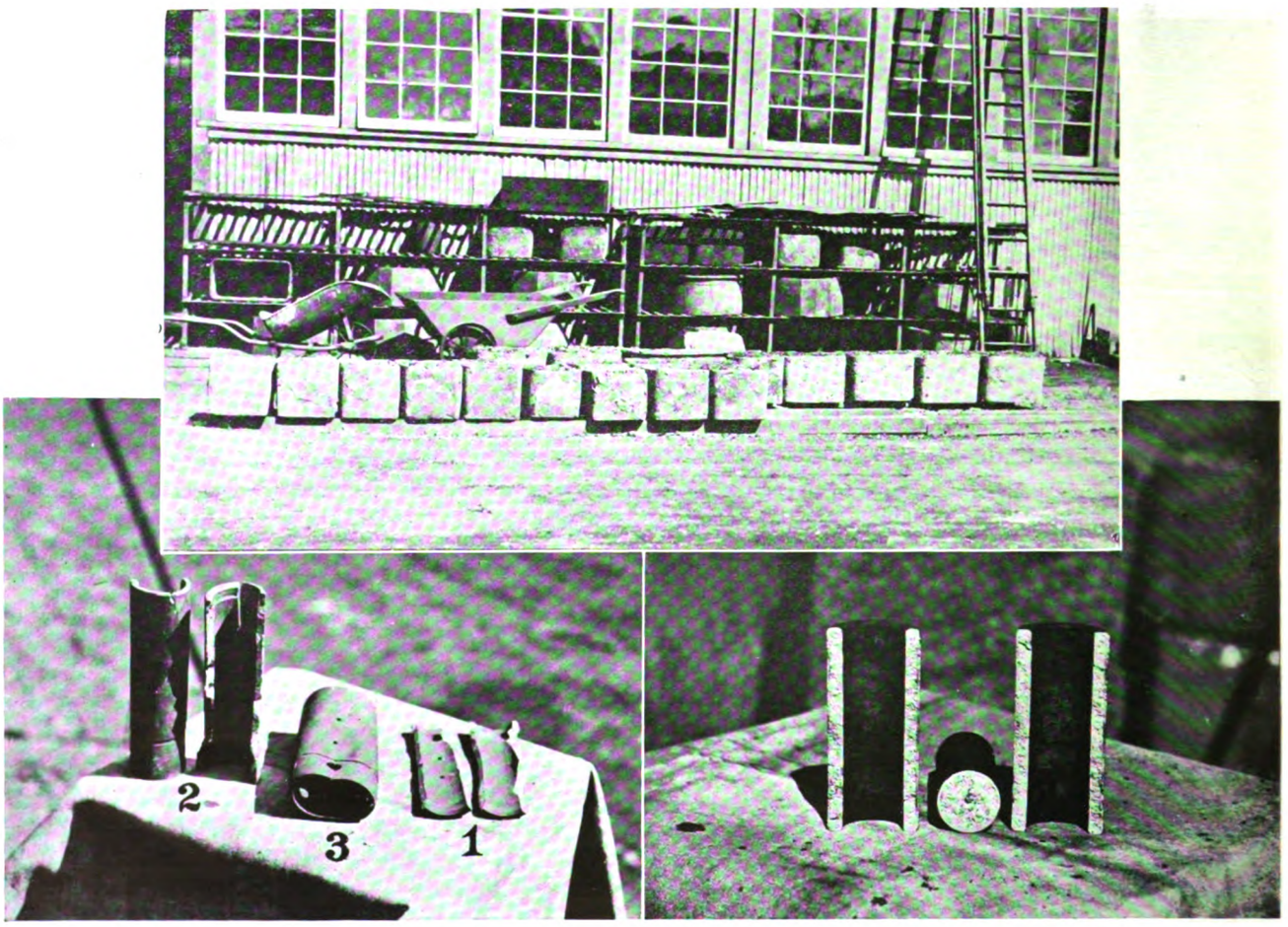
The work is packed in these boxes with a suitable mixture of granulated bone and charcoal. The regular mixture consists of new bone 20%, charcoal 20%, spent material 60%, giving an average depth of case of 3/64 in. Richer mixtures are made according to the depth of case desired. The box lids are luted with a mixture of wet fire-clay and sand to prevent the escape of carbonaceous gases.

Commencing with the first shift at 11 p. m. Sunday night, these boxes are loaded into the furnaces, the fires started, and the furnaces brought to a temperature from 1750° F. to 1800° F., and held at this point for eight hours. The second shift, working from 7 a. m. to 3 p. m., have no heats to pull from the carbonizing furnaces on Mondays, but pack for another heat and do reheating. The third shift, working from 3 to 11, pull the first heat of the week at 7 p. m. Monday and reload the furnaces with boxes packed, which are cold. The men of the first shift then pack for the coming heat and do reheating. At 7 a. m. Tuesday the second shift dump the boxes, separate the work from the carbonizing material, pull the heat in the furnaces, and reload again. Four hours is allowed to heat the boxes and material and eight hours carbonizing time at the given temperature. This allows eight hours for the hot boxes to cool before separating the carbonizing material from the work. No work is quenched directly from the boxes as this gives a case too brittle for much use. Instead the work is reheated according to its physical requirements. For ordinary work, for which wearing qualities are desired more than toughness, the work is heated to 1400° F. and quenched in brine. For parts where endurance to both shock and wear are essential, such as transmission-gears and wrist-pins, a different heat treatment is required. These parts are packed in a suitable mixture of carbonizing material, carbonized for eight hours at a temperature of 1750° F., withdrawn from the fire, and allowed to cool in the boxes. They are then separated and given a double quenching in brine, the object of this being to refine the grain of both core and case. Fig. 1 and 2 illustrate the effect of this double quenching. The part is a piston-pin. No. 1 was heated to 1400° F. and quenched in brine. It showed no toughness in the core and was easily broken. No. 2 was heated to 1600° F. and quenched. This gave a little toughness in the core but the case was hard and brittle. No. 3 was heated to 1700° F., quenched in water, and again heated to 1400° F. and quenched in water. It would not break completely, and shows where fractured, a fine tough grain in both case and core, capable of withstanding great shock and giving excellent wearing qualities. The case on all three specimens



LOWER LEFT, WRIST-PINS DIFFERENTLY HEAT TREATED. FOR DESCRIPTION SEE TEXT. LOWER RIGHT, CASEHARDENED PARTS AFTER FRACTURE. ABOVE, BOXES OF CARBURIZED PARTS COOLING

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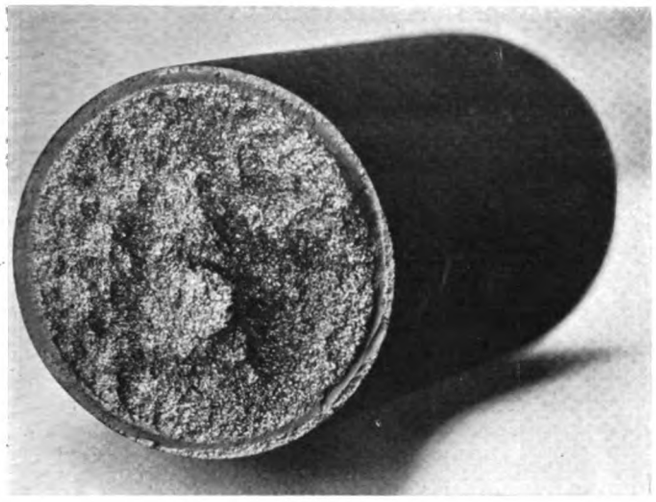
had a depth of 3/32 in. and showed a scleroscope hardness of 80 to 90.

With the methods thus adopted as to time, temperature, and material used, a force of twelve men is able to caseharden and heat-treat 140,000 lb. of work per month (based on a 6 months' average). This is 75% of the work handled in this department.

Most parts are given about the same depth of case, the same length of time in the furnaces, and the same temperature. This is accomplished by using different carbonizing mixtures of bone and charcoal according to the varying sizes of work, but small parts, such as jam-



FRACTURE OF CASEHARDENED ROD

nuts, set-screws, and thin washers, are packed in small circular pots and carbonized from 30 minutes to 5 hours.

Other parts made of the different alloy steels are not casehardened but are heat treated according to standard specifications. The treatment usually consists of a double quenching in oil for nickel and nickel-chromium steels, drawing or tempering them afterward, according to the degree of hardness desired. The manganese-steel castings, which contain from 0.40% to 0.80% manganese, the average being about 0.65%, are given a single quenching in oil and are drawn or tempered.

The Defense of the Present Social Order Against Radicalism

Something more than constitutional law and the mandates of the courts will be necessary to meet the social and economic conditions the world is facing, the National Bank of Commerce of New York asserts in its publication, 'Commerce Monthly,' for October under the heading 'Is Private Property Secure?' Social expediency and social welfare, it says, are the tests demanded for present conditions of living and are the logical guides to the solution of the problems presented by the growing assaults on private property, free enterprise, and competition.

After reviewing the assaults made upon private property, free enterprise, and competition by the various cults of social radicals, the article says:

"A wise social policy in the future, aimed at the abolition of poverty, will seek both to restrict the numbers of the population, and to prevent the further breeding of those elements of the population which are by birth condemned to inferiority. It will also lay heavy emphasis on efficiency in production.

"What shall we say for private property, free enterprise, and competition, against one or all of which the shafts of the social radicals are aimed? We must hold that these fundamentals of the present social order are vitally important, and thoroughly defensible. Modifications in them we must make, but in the interests of social welfare we must defend them.

"It is no valid defense of them, however, to say that they are lawful, that they are established by constitutional law, by court decisions, and long custom. The time is past when men are willing to draw their conceptions of justice from lawyers or from ancient custom. Institutions must stand on their own merits, and they must be tested by the fundamental test of social welfare. Do they, or do they not promote the well-being of society?

"They do. Private property, for example, corresponds first to a fundamental human instinct, the instinct of acquisition, the instinct of possession. As man is constituted, he desires to own and to hold things. It is by appeal to these elementary things in human nature that we draw out men's energies. The desire for private property is one of the most powerful agencies that can be found for spurring men to effort. Men will work harder for their personal ends than they will for general public ends. Men will take better care of their own property than they will of what belongs to the group as a whole. A system in which each man is made responsible for his own welfare and the welfare of his family leads to far greater effort on the part of men than any other system known. Industries run by governments are in general more wastefully conducted than are industries run by private individuals, whose profits depend on the outcome of the operations. Exceptions can be found among some municipal enterprises, in which the activity under observation is relatively simple and comprehensible, but few exceptions can be found among the enterprises conducted by great governments. Whatever else we may seek to do in improving the social order, we must not do anything that will lessen the efficiency of production. The fundamental fact in the whole social problem is that we do not now produce enough.

"This does not mean, however, that all phases of private property and all of the rights connected with private property should be regarded as sacred and not subject to criticism. Private property should be subject always to public regulation and subordinated to the

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public interest. In a great city, a man should not be allowed to put up a high building in such a manner as to cut off light and air from his neighbors. We do not allow men to maintain public nuisances upon their private property. In arid and semi-arid regions, the rights to streams flowing through a piece of land are subject to the larger common need. If private property is needed for public use, it may be taken either by taxation or under the rules of eminent domain. Again how far is the unlimited right of bequest or inheritance an essential part of private property right? And again, is it necessary in order for us to get the best out of private property for social purposes that fortunes should be allowed to grow to unlimited size? These are questions about which we may well ponder.

"With reference to competition, the case is equally clear. The instinct of rivalry is fundamental in human nature, and the spur of competition is needed to make men do their best. Competition is the protection of the consumer against high prices, which accompany exorbitant profits. It is the automatic force that reduces the gains of the inefficient and makes profits depend upon low rather than on high prices. It evokes in individuals the fundamental characteristics of energy, thrift, and power. It harmonizes the interests of the individual and of society.

"Whether competition is wholesome or not depends upon the level of competition. When unfair and unwholesome methods of competition are introduced, the adulteration of goods, the making of false representation, local underselling for the purpose of ruining a local competitor, these and other unfair methods can and should be prevented. Trade practices and public sentiment go far in this matter. Where necessary, the law should intervene. The game of business competition must be played fairly. There must be no hitting below the belt.

"Free enterprise, again, together with competition and private property, is vital to economic progress. The man with ideas and initiative must be given free scope to carry out his plans. By and large, free private enterprise is so superior to government ownership of industry, or to industry under government regulations, that the man who has seen both systems in operation intimately can have little doubt about the matter.

"Free enterprise and competition are undesirable under some conditions. There is general agreement that unregulated competition between two parallel lines of railroads may bankrupt one or both. Competing telephone systems in a given city are pernicious. There is no room for competing street-railway systems upon the city streets. In cases of this sort we reluctantly surrender competition, and we introduce government regulation. Unregulated monopoly, virtually all agree, is intolerable. In cases where monopoly is inevitable, we accept the fact. We make the best of it by subjecting it to government control. But when we do this, the demand of the Socialists for going further becomes insistent and strong, because they feel that the full realization of their program is within sight. A powerful political movement arises for government ownership of railroads, or telegraphs, and the like, and it is not certain that this movement can be resisted. Even in the cases of regulated monopoly, however, private is preferable to government ownership. Private ownership even under government regulation is more efficient than government ownership and operation, but business men will do well to realize that there is no certainty that private ownership can be retained in these cases. If industry generally is allowed to become highly concentrated and combined under the regulation of such a body as the Federal Trade Commission, it may not be long before the movement for government ownership and control will become powerful.

"For the general field of industry, private enterprise and competition must, in the long run, share the same fortune."

Less Rigid Sulphur Limits in Steel Castings Advocated

A plea for a less rigid adherence to prescribed sulphur limits in steel castings and for greater attention to other factors affecting quality was made by A. E. White in an address delivered at the recent convention of the American Foundrymen's Association. Five main factors were mentioned as affecting the quality of steel castings; namely, design, composition, molding practice, steel-making practice, and annealing practice. Sulphur in steel may increase blowholes, although this is a disputed point, but assuming that it does, it will not do so to the same extent as either improper temper to the mold, improper venting of the mold or core, or an improper pouring temperature. It may increase shrinkage, but it will not do it nearly as much as an improper casting design, an improper pouring temperature, or too rapid heating or cooling during annealing. It may decrease the metal's resistance to shock, but not to the degree that a poorly designed casting will, or one in which the metal has been overheated, burned, or under-annealed with the dendritic structure still in evidence. In general, the speaker advocated the placing of the acceptance or rejection of steel castings on a broader basis than that which at present prevails.

A BASHFUL curate found the young ladies in a parish too helpful. At last it became so embarrassing that he left.

Not long afterward he met the curate who had succeeded him.

"Well," he asked, "how do you get on with the ladies?"

"Oh, very well indeed," said the other. "There is safety in numbers, you know."

"Ah!" was the instant reply. "I only found it in Exodus."—'Dallas News.'

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Employment Methods and Profit-Sharing at the Bean Spray Pump Co. Plant

THE principal features of the Bean company's employment policy are a closed non-union shop, a premium system, a profit-sharing system, and an accounting system that gives the employee quick action in getting his premiums and share of profits. The reader must decide for himself whether or not the company is well-advised in adopting these plans, and how far, if at all, they could be followed by other industrial concerns.

THE Bean Spray Pump Co., as the name indicates, was originally formed to manufacture pumps for spraying fruit-trees with insecticides. The company's business grew slowly at first, as can be gathered from the fact that when the shop was moved in 1907, from Los Gatos, where it was originally established, to San Jose, the entire outfit, patterns, tools, and all, was hauled on a two-horse wagon. Since then, the prosperity of the orchard and other agricultural industries combined with increasing recognition by the more progressive farmers of the necessity for suitable equipment in their operation has contributed to increase the sales of the company's machinery. By degrees, the manufacture of well-pumps, tractors, and other agricultural machinery was taken up, while the old-style hand spray-pump has been practically supplanted by the power pump. For a long time the company did considerable jobbing work, particularly for orchardists that used its manufactured articles, but this has been discontinued, and the company is now on a strictly manufacturing basis. At present about 275 men and women are employed in the various shop departments, and the gross annual business is approximately $1,500,000.

BEAN SPRAY PUMP COMPANY
LABOR AGREEMENT

Date..... Ck. No.....

I, the undersigned, am employed by and agree to work for the Bean Spray Pump Co., with the express understanding that I am not now a member of any Union Labor Organization or Trades Union, and will not become so while an employe of the Bean Spray Pump Co.; it is further understood that the Bean Spray Pump Co. is run non-union and agrees with me that it will continue to run non-union while I am in its employ. If, at any time, while I am employed by the Bean Spray Pump Co., I want to become connected with any Union Labor Organization or Trades Union, I agree to withdraw from the employment of said Company, and I further agree that while I am in the employ of that Company, I will not make any efforts among its employes to bring about the unionization of the Company's plant or its employes, against the Company's wish.

I have either read the above or heard it read and fully understand its meaning.

Signed.....

FIG. 1. AGREEMENT SIGNED BY EMPLOYEES BEFORE COMMENCING WORK

Up to about two years ago, there was no general labor policy for the entire plant. Some departments were run union and others open shop. This condition would probably have continued if, at that time, the men in several departments had not been called out because of a strike. This strike does not appear to have involved local working conditions or any other matters directly under the company's control. As a result of this trouble the company adopted a closed non-union policy. Every man and woman entering the employ of the company signs an agreement such as is shown in Fig. 1. This agreement has the same wording as the one that was sustained as constitutional by the U. S. Supreme Court in the Hitchman Coal Co. case. Under all conditions the company deals directly with the individual employee.

Wherever the work is of such a character that a time for completing each job can be set, the shop employees are placed on premium work. At present about half of them are on day work and about half on premium work. The base rate paid is the going rate for the particular class of work. On premium work a reasonable time for doing each job is established by an expert time-setter, and this time, once established, can be changed only if the facilities are improved or by mutual consent. Savings made by the individual employee as a result of doing the work more rapidly than the time set are divided equally between the company and the employee. Records are kept on the premium card shown in Fig. 2. As will be seen, the '50/50' idea is kept prominently before the worker.

More important, perhaps, than even the method of computing the payment of premiums is the fact that the industrious and efficient worker does not have to wait for a considerable time for the special reward of his efforts. Both the regular payroll and the premiums are computed at the end of each week, and payment is made every Tuesday in full for all work done the previous week. The average wage including premiums of many skilled workers is more than $10 per day.

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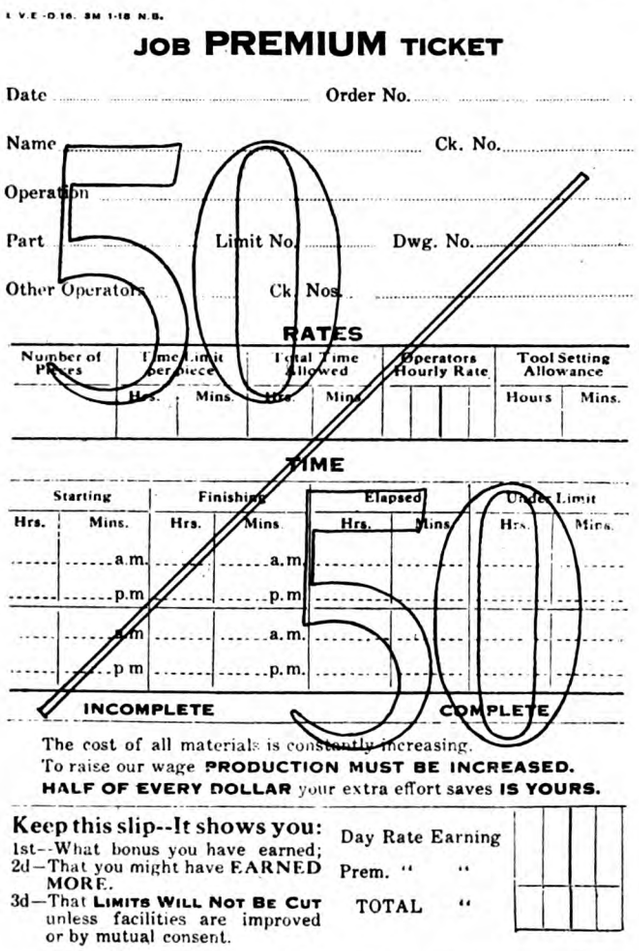
All hiring of new employees in the shop departments is done through the works manager. Where a new employee is untrained he is instructed by the foreman or by some other expert mechanic. When a new employee, either already skilled or trained in the factory, has shown himself to be familiar with the work required, he is allowed to go on premium work.

For some years past, all employees have been encouraged to purchase stock in the company, paying for it in small monthly installments, and up to the time the Liberty Bond drives diverted all surplus funds to the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JOB PREMIUM TICKET

Date ..... Order No. .....

Name ..... Ck. No. .....

Operation .....

Part ..... Limit No. ..... Dwg. No. .....

Other Operators ..... Ck. Nos. .....

RATES

Number of Pieces	Time Limit per piece		Total Time Allowed		Operators Hourly Rate	Tool Setting Allowance	
	Hrs.	Mins.	Hrs.	Mins.		Hours	Mins.

TIME

Starting		Finishing		Elapsed		Under Limit	
Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.
	a.m.		a.m.				
	p.m.		p.m.				
	a.m.		a.m.				
	p.m.		p.m.				

INCOMPLETE COMPLETE

The cost of all materials is constantly increasing.
To raise our wage PRODUCTION MUST BE INCREASED.
HALF OF EVERY DOLLAR your extra effort saves IS YOURS.

Keep this slip--It shows you:
1st--What bonus you have earned;
2d—That you might have EARNED MORE.
3d—That LIMITS WILL NOT BE CUT unless facilities are improved or by mutual consent.

Day Rate Earning
Prem. " "
TOTAL "

FIG. 2. PREMIUM-RECORD FORM

needs of the Government, a considerable amount of stock had been so purchased. Encouraged by the success of this plan, and wishing further to promote the welfare of every employee as well as co-operation between all employees and all departments, the company officials developed a profit-sharing system, which was accepted by a vote of the employees on August 30 last. The general features of the plan are described in a circular issued by the company to its employees as follows:

"After paying all employees their salary or wages on the going basis and setting aside dividends as provided by law on the preferred stock* and at the rate of 10% on the common stock, both cumulative, an amount not exceeding one-half of the remaining profits, hereafter called 'surplus profits,' shall be set aside in the employees' 'profit fund.'

"Section 1.—The profit fund.

"The profit fund shall be made up as follows:

"1. At the close of each fiscal year, after having set aside dividends as above outlined, one-fourth of the 'surplus profits' known as 'profit distribution,' shall be placed in the 'profit fund' and divided into 12 equal parts. The amount of this total and of the monthly portions for the year shall be promptly posted in the factory.

"2. To the above amount there shall be added monthly the following:

(*a*) One-half of the company's half of all premiums earned in the factory during the month.

(*b*) One-half of the net saving in factory overhead for the season to date, less previous payments for that year.

(*c*) One-half of the net saving in office and administrative overhead for the season to date, less previous payments that year.†

(*d*) One-half of the net saving in sales expense for the season to date, less previous payments that year.†

"3. The total of the items under paragraph 2 of this section for any given year shall not exceed the total under Item 1. The maximum distribution will, therefore, not exceed one-half of the surplus profits.

It will be noted from the above that each of the three departments, factories, office, and sales (including branches), should contribute to the profit fund by extra efficiency.

"Section 2.—General plan of distribution.

"The essential features of the plan of distribution are as follows:

"1. Monthly profit-sharing payments.

"2. Individual merit of employee together with income and length of service to determine his or her proportion.

"3. New employees begin participation upon successful completion of the probationary period, 10 to 12 months after first employment. Since at least half the profit fund is made up from surplus profits of the previous year, new employees participate in the first profits they have helped to earn.

"4. 'Profit shares' are cumulative during continuous employment, including 'leave of absence.'

"Section 3.—Computing each employee's share.

"1. There shall be a possible 100 merits obtainable each month. Securing of 1000 merits within the course of 12 months will be necessary for advancement to the next higher grade. Having earned the necessary merits, employees then participate in the profit fund in proportion that the number of profit shares they own bear to the total profit shares of all employees.

"2. There shall be five grades of employees, as follows:

Probationers, new employees, until they have earned 1000 merits within 12 months.

*This stock pays 6% and 7% according to the issue.

†The savings shall be computed against the average expense of the last three years, viz: July 1, 1916 to June 30, 1919.

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Third grade, employees that have earned 1000 merits within 12 months.

Second grade, employees that have earned a second 1000 merits within another 12 months.

First grade, employees that have earned a third 1000 merits within another 12 months.

Senior grade, employees that have earned a fourth 1000 merits within another 12 months.

Employees continue in this senior grade during continuous employment as long as they continue earning 1000 additional merits each 12 months.

"3. There shall be three classes of employees from office-boy to president, depending upon earnings, as follows:

Class C, employees earning less than 40c. per hour or less than $70 per month.

Class B, employees earning 40c. to less than 80c. per hour of $70 to less than $150 per month.

Class A, employees earning 80c. or more per hour or $150 or more per month.

"4. Profit shares earned by promotion to the various grades for the various classes are as follows:

Number of Profit Shares Earned

	3rd grade	2nd grade additional	1st grade additional	Senior additional	Total of 4 grades	Per year thereafter
Class C.....	3	2	1	1	7	1
Class B.....	4	3	2	1	10	1
Class A.....	5	4	3	2	14	1

Add the profit shares earned in your class and grade to all others earned later to determine your total number of profit shares.

"5. The securing of merits and additional profit shares shall be continuous throughout the period of employment.

"6. Special merits for particularly meritorious service can be accorded under the rules as later provided, and in rare cases, very special and valuable services may be rewarded with one or more profit shares applicable for one or more years, such profit shares to be awarded only upon written approval of the president or general manager.

"7. The sum of the profit shares of all employees divided into the profit fund to be distributed for a given month shall determine the value of each profit share for that particular month. Each employee entitled to participate shall then be paid his proportion determined by multiplying the number of his shares by the value per share.

"8. Effort shall be made to distribute profit-sharing checks for a given month on the third pay-day of the succeeding month.

"Section 4.—Vacations and continuity of employment.

"1. In addition to the profit-sharing as above outlined, all employees working on the hourly rate shall be awarded vacations (which shall include time off at full pay for any cause) as follows:

Third grade, one-half week.
Second grade, one week.
First grade, one and one-half weeks.
Senior grade, two weeks.

Suitable time for taking vacation on full pay, other than for sickness, shall be arranged with the foreman or superior in charge.

"2. Employees in any grade will not be laid off if work should become slack until all employees in a lower grade doing same class of work shall have been released.

Employees in Grade 3 shall not be discharged without being given a second chance to make good either at the same work or in some other position.

Employees in Grade 2 shall not be discharged except after having had a second chance and then only on written report of the foreman, with right of appeal to the works manager, or in the case of the clerical or sales force, to the office or sales manager.

Employees in Grade 1 shall not be discharged except after having had a second chance and then only on written report of the foreman with written approval of the manager of the department.

Employees in the Senior Grade shall not be discharged except on written report of the foreman signed by the manager of the department, and approved by the general manager or the president.

The one exception shall be the committing of one of the 'Capital Offenses.'‡

"Section 5.—Starting the plan.

"In order to start the plan all employees shall be divided into four groups.

"1. Those who have been with the company three years or more on August 30, 1919, shall be placed in Grade 2.

"2. Those who have been with the company one year or less than three years on August 30, 1919, shall be placed in Grade 3.

"3. Those with the company more than six months and less than one year on August 30, 1919, shall be placed in the probationary group but given credit for 500 merits so that, upon securing 500 additional merits within six months from September 1 they shall be advanced to Grade 3 and begin participation in the profit fund.

"4. Those with the company less than six months on August 30, 1919, shall become probationers and be advanced to Grade 3 and participate in the profit fund the same as any new employee, upon securing 1000 merits within 12 months from September 1, 1919."

The estimated distribution from the profit fund will provide approximately $2 per month for each profit share.

The following system is used in determining merits. Each employee starts with a perfect score of 100 merits each month, and deductions are made from this amount

‡These 'capital offenses' are as follows:

1. Stealing.
2. Causing any disturbance.
3. Wilfully destroying property.
5. Failure to qualify.
6. Leaving premises during working-hours without permission.
7. Breach of ordinary rules of decency.
8. Fighting on the company's premises, in which event both of the belligerents will be considered as equally guilty without regard to initial provocation.
9. Malicious mischief causing damage to the person or loss to the company.
10. Offering insult to female employees.

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for irregular attendance, spoiled work, inefficiency, etc.

The basic idea underlying the present labor and employment policy of the Bean Spray Pump Co., besides the desire to deal fairly with all concerned, appears to be the assumption that, given good working conditions, the individual employees of the company have little interest in broad questions of factory management and operation, but are greatly interested in how much money they can make by their labor, when they are going to get it, and what assurance they have that their job will be secure. The premium system ensures the worker, in addition to a basic living wage, a reward proportional to his efforts. The profit-sharing plan gives every worker a direct interest in the efficiency of every other worker, and in the collective efficiency of all departments.

An important feature of the labor policy of the company is the employment of a number of women in the various shop departments, who are engaged in making small cores, running drill-presses, and similar work. They are paid the same base rate as the men for the same work, and many of them earn substantial premiums in addition. They learn readily, and for certain classes of work are more satisfactory than men. The company requires the wearing of a special 'cover-all' uniform, which ensures against the special hazards usually found when women and machinery are associated. This uniform is supplied at a price somewhat below the actual wholesale cost. Ample dressing-room facilities are provided for the women, as well as a dining-room with a gas range for heating their lunches. There is also a rest-room, but the management reports that the women seem to have little use for it, indicating, at least, that their work is not too arduous.

Acknowledgement should be made to James H. Delany, works manager for the company, for assistance in preparing this article.

Recreational Activities in the Industrial Plants of Berkeley

The first attempts of any importance at recreational activities in the factories of West Berkeley were made at the plant of Peet Bros. Soap Co. about three or four years ago, when the management, with the co-operation of Gustavus Schneider, city playground superintendent, began to encourage sports during the noon period as a means of providing healthy amusements. Quoits was the first game tried and this continues the favorite among the older men, but the younger men, as a rule, want something with more action and competition in it. Volley-ball was next introduced, and this is still the favorite game, although facilities are also provided for baseball, tennis, and basketball for both men and women. Peet Bros. plant is unusually favorably situated in having plenty of room on the property for outdoor sports. In addition, the top floor of a building recently erected is devoted entirely to indoor sports, for use when the weather is inclement. Two playground directors, one for the men and one for the women, from Mr. Schneider's staff, are at the factory every day during the noon hour, the company paying their salaries.

Recreational activities have developed further at Peet Bros. factory than in any of the other industrial plants, largely because of the enthusiastic co-operation of C. C. Newkirk, superintendent of the plant, who not only helps to obtain the necessary funds, but also takes part in the games himself. That the employees appreciate the recreational program is shown in a number of ways. For instance, when the recreational activities were first started, the regular noon period was 45 minutes. At the employees' request it was lengthened to one hour in order to give more time for recreation. 'Quitting time' at night was placed 15 minutes later so that the actual working time was the same. Later, a movement was started to return to the old 45-minute period, with the same total of working hours, but this was indignantly voted down by the majority of the employees.

A number of the other factories in Berkeley have also taken up the recreational program, under the auspices of the Industrial Department of the Berkeley Y. M. C. A. This work is under the direction of George Collins, the Association's industrial secretary. Mr. Collins is working in co-operation with Mr. Schneider so that duplication of effort is avoided.

Volley-ball is the favorite game. It gives sufficient action to be interesting without being so strenuous as to interfere with its being played with comfort directly after a meal. It is also easy to learn and provides for a large number of players. One of the particular objects of the recreational program is to get the maximum number of people actively engaged in the games.

In addition to the noon-hour games, a series of 'twilight' baseball games under Mr. Schneider's direction was played after work hours between teams from several of the plants in the industrial district, including the Hall-Scott Motor Car Co., Byron Jackson Iron Works, H. C. Macauley Foundry Co. and several other firms. For all these games, the various companies provide the necessary equipment, and where a recreational director comes to the plant regularly, pay his or her salary also.

Another part of Mr. Schneider's work, which is indirectly related to the industrial-plant activities, is the holding of community 'recreation evenings' for adults in the various school-buildings, at which games are played and everybody in the community has a good time. During the last fiscal year, in spite of the time lost during the influenza epidemics, 55 of these recreation evenings were held in school-buildings in various parts of the city, and the total attendance was more than 8000.

While the recreational activities in Berkeley's industrial district were started comparatively recently, the usual effects of such a program have been observed, namely, that those partaking in them are healthier in both body and mind, and that relations are improved between employees and between employer and employees.

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The Physical Examination in Industry

The demand of the strikers in the steel industry for the abolition of the physical examination before employment renders the address of Dr. C. D. Selby, delivered at the recent convention of the National Safety Council, of particular interest. Dr. Selby called attention to the fact that the procurement of healthy, physically competent workmen may imply the rejection of those who are not so. However, it does not necessarily follow that such should be rejected outright and deprived of the privilege of gainful occupation. There are positions in industry, in fact in virtually every plant of reasonable size, that people of sub-standard conditions of health and body can fill with efficiency, to the profit of their employers and themselves. For example, defective eyesight may justly disqualify a man from operating a machine that requires acuteness of vision, and yet permit him to supervise a gang of laborers with competency. Again, chronic bronchitis may render employment in a foundry hazardous and unprofitable, while in the open it may have no detrimental effect. Even the blind and the legless, the tubercular and the nephritic, are capable of productive labor under proper conditions of employment. That only the manifestly unfit and the victims of communicable disease should be rejected, is a growing opinion among employment managers. The procurement of health and physical competency among employees requires that they be selected for and assigned to jobs to which they are or can be adapted—with rejection a last resort.

The scope of the examination should be broad enough to enable physicians to gather the information that is requisite. This means it should uncover defects and diseases that render employment hazardous to him who seeks it or to his fellow workmen. It should uncover imperfections that contribute to inefficiency. It should uncover diseases and sub-standard conditions of health. In short, the examination should be such as to divulge the true condition; it should be fairly comprehensive.

Although a complete physical examination, with blood-pressure readings, urinalysis, and other laboratory tests, is desirable in industry, it is not always practical. In the first place, industry has not found it necessary except in unusual cases, and, in the second place, industrial physicians are usually too pressed for time to investigate deeply. Experience has gradually evolved four grades of examination, depending upon the objective sought, which in turn is frequently fixed by the policy of the company immediately concerned. They are as follows:

1. Superficial inspection. This consists of a hasty survey for obvious defects and apparent sickness. It considers height, weight, appearance, deformities, distance vision, hearing, hernia, and occasionally the heart and lungs. Its objective is rejection of the evidently unfit and the exclusion of communicable diseases.

2. Inspection. This consists of a more complete survey. All parts of the body are exposed and their condition noted. Diagnostic instruments are used when in the opinion of the physician they are needed. This is practically an examination—without urinalysis and other laboratory tests. Its objective is selection and assignment of workers.

3. Examination. This consists of a reasonably complete survey of the body according to accepted methods, and includes blood-pressure readings and urinalysis. It is virtually the same as the examination required by life-insurance companies. Its objective is not only the selection and assignment of workers, but their health supervision as well.

4. Special examination. This consists of all measures that are necessary to a thorough study of the body, including intra-ocular observations, gastric analysis, rectoscopy, cystoscopy, x-ray interpretations, investigations of the nervous system, blood counts, etc. Few industrial physicians are prepared to make such elaborate and painstaking examinations. Individuals needing them are usually referred to consultants.

The objective of the special examination is the diagnosis of obscure diseases and pathological conditions. It belongs rather to the realm of internal medicine than to industrial clinics.

Inasmuch as by far the greatest number of occasions for investigation into the physical state of industrial workers occur when they seek employment, the inspection would appear to be the most useful of the four grades. It has the advantage of gaining enough information to enable physicians to eliminate the manifestly unfit, if desired, and to advise intelligently in the assignment of others, and to do so with a minimum expenditure of time. Furthermore, it secures enough information for physicians to determine which individuals must have additional study, in the form of the examination or special examination, for the intelligent supervision of their health.

THERE was once a politician, formerly a farmer, whose reputation was such that a colleague, meeting an old man from his district, asked confidentially:

"What do you think of him down your way? Is he an honest man?"

The countryman stroked his whiskers and smiled.

"Would you call him a liar?" asked the other.

Another stroking of the whiskers, then he replied:

"Well, now, I don't know that I'd go so far as to call him a liar, but those as know him down our way do say that when he wanted his pigs to come for their feed he had to get somebody else to call 'em."—'Boston Globe.'

CLIENT—"This bill of yours is exorbitant. There are several items in it that I don't understand at all." Lawyer—"I am perfectly willing to explain it; the explanation will cost you $10."—Boston Transcript.

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The Traveling-Crane From the Safety Standpoint

In an address delivered at the recent meeting of the National Safety Council, Chester C. Rausch, assistant director of the Safety Institute of America, called attention to the fact that many well-designed crane installations operate over inadequately illuminated spaces. The fact that the operator is a considerable distance above the floor where the atachments to the crane-hook are made, and that his view is frequently obstructed by a haze caused by manufacturing processes, in spite of proper ventilation, only aggravates an already bad condition. This hazy atmosphere may be permanent or may be only a temporary condition. For example, a foundry is often troubled with this haze during a pour, and a machine-shop that is generally clear may become clouded for a part of the day as a result of a large babbiting operation done inside the shop or from the wafting of smoke or fumes into the shop from other parts of the building or from out-of-doors. On days when natural illumination varies, the lights sometimes are not turned on during the darker periods, so that there are periods of comparatively poor illumination from the crane-operator's standpoint. In many shops the artificial illumination is not sufficient to afford adequate vision at any time. It may be too expensive to increase the general illumination for the benefit of a single crane-operator and in such cases, and also when illumination is good, excellent results have been obtained by attaching to the crane-trolley one or more lights properly covered with a focusing reflector and arranged so that the area immediately about the hook when at its lowest point and near the floor is brightly illuminated. Such illumination tends not only to assist the crane-operator to observe what is being done on the floor but helps the crane attendant to make proper attachments to the load. Furthermore, when the load is traveling down the shop the brilliant illumination throws it into bold relief and serves as a warning of its approach. In many shops the hook of the crane is painted white and kept white in order that it shall attract attention to itself and furnish an indication to the crane-operator of its position with reference to the floor. When such a hook is illuminated by overhead lights as just suggested, it is doubly conspicuous.

Attaching one or more lights to the crane-trolley gives the operator a chance to see what he is doing when otherwise the illumination is poor.

Many overhead traveling-cranes have none of the electrical equipment in the cab properly guarded. There are exposed contact-points, circuit-breakers, knife-switches, and terminal lugs carrying from 110 to 500 volts or more. Contact with these exposed points may either kill a crane-operator, or, at least, temporarily incapacitate him so that his crane continues its motions uncontrolled. The use of the simplest form of shields or guards composed of asbestos, wood, sheet-metal, or other material are not only easily applied but inexpensive. The possibility of serious accident in the movement of an uncontrolled crane is sufficiently great to require ample protection for the crane-operator and the specifications for new equipment should have only back-connected control-panels and inclosed resistance-grids.

In many shops, lighting fixtures arranged to furnish general illumination of the floor are, from necessity, placed above the travel-way of the crane. If such buildings have wide spans the crane-operator, unless properly shielded by an awning to his cab, is confronted in his view up and down and frequently across the shop with many spots of brilliant and glaring light that serve to confuse his vision. In some shops this general illumination from above the crane-way is augmented by lamps having angle-reflectors, and too often no reflectors at all, placed just below the crane-runway. When operating the trolley on the far side of the shop these lamps throw a steady stream of light into the face of the operator, seriously confusing his action. Such lamps should be shielded from above with reference to any position the load to be observed by the crane-operator must assume.

Lights intended for the general illumination of the floor should be shielded if they interfere with the operator's view.

Many cranes have practically nothing but a hand-rail to keep the operator in the cab. During his slack moments, when he is comfortably stretched on a box, stool, or bench, any lapse of consciousness would permit him to shoot under this rail and fall to the floor below. There is no reason why the crane should not be enclosed to a reasonable height with grillage to prevent such an accident and in a manner that need in no way interfere with the craneman's vision or movements.

Cranes, like all other apparatus, require occasional repairs and continual maintenance. It is almost criminal to fail to provide an adequate repair-deck from which oiling, adjustments, and repairs may be safely performed. There is scarcely a shop where such a deck cannot be provided at one end or the other for at least a part of the width of the crane-span. Although

An adequate repair-deck, from which oiling, adjustment, and repairs be performed safely, should be provided.

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many heavy parts are used in the construction of the trolley of a crane, no provision is made for a small wall-crane or a traveling chain-hoist to assist in this work. Many times repair-men are exposed to serious hazards from falling on account of this lack. Frequently the bottom-chords of the roof-trusses are used in making repairs, and at such times they are subjected to strains that they were never designed to withstand. Workmen are frequently obliged to make crane-repairs after dark and to use electric drills or soldering-irons in connection with their work. The placing of a few plug-receptacles for the attachment of portable extensions to make connections to these tools would greatly assist in their work.

Most cranes are now fitted with an over-hoist or over-travel stop that automatically arrests the upward travel of the hook and its load if the operator fails to disconnect the power of the hoisting-motor as the hook-block approaches the hoisting-drum. On large cranes that handle heavy loads the hook-travel upward is slow and frequently the part being hoisted requires the maximum upward-travel of the hook. Crane-operators have been known to turn on the power and to wait calmly for the load to come into contact with the over-travel release, thus disconnecting the motor. The fallacy and danger of such operations are evident and should be matters of strict discipline.

Lubrication of cables is sometimes accompanied by a man standing on the trolley, who applies the grease as the cable is wound on the drum. Sometimes the cable is all wound and the top-half of the drum properly greased. The bottom-half is then greased after the drum has made a half revolution to bring the ungreased cable on the upper side. I recently saw a clever greasing device, which could be attached temporarily to the top of the hoisting-block in such a way that an arm holding a collar made of soft wicking could project out and surround the cable. This arm was connected with a tank supplying grease in such a way that the cable, by passing through the collar, became properly lubricated throughout its entire length.

Many cranes are operated without a safe or convenient means of access to their cabs. The daily exposure of operators to falling, to contact with live wires, or to being overcome by fumes or gases while climbing to their cabs is considerable. Not only new structures, but old structures as well, should be equipped with either a properly enclosed ladder or else an adequate stairway by which the cab could be reached with a minimum of danger.

Many traveling-cranes handle material by means of electro-magnetic lifting devices. These are so ruggedly constructed that they will withstand almost unlimited abuse. The only weak links in their safe operation are the cable connecting them to the source of power and the power-supply itself. Usually the source of power is sufficiently reliable to make failure only a remote possibility. The cable, however, is subjected to all manner of rough handling as a result of following the movements of the magnet and also because of contact with the ground, with material being handled and, sometimes, with the devices that are used to keep the slack of the cable from fouling itself with the boom. One of the best solutions of this difficulty has been the adoption of a cable that can follow the magnet in the same manner that the lifting-cable follows it. If this cable passes over a suitably grooved pulley at the tip of the boom, or on the trolley-drum of the crane, and is so arranged that a counterweight will carry the slack down the boom or so that the slack will wind up on the drum of the trolley, most of the wear can be avoided. Suitable electrical connections can be made by means of contact with a sliding bar or with a rotary collector-ring on the trolley-winding drum. A proper application of this device will not only give longer life for the cable but avoid damage from kinks, cuts, abrasions, and strains.

Crane-hooks are often overloaded. While the hazard created by the improper use of chains is well known, a considerable number of floor-men introduce strains in crane-hooks that they cannot stand without serious deformation or breaking. In handling some objects, several chains are used so that the mouth of the hook is filled, and attachments are made to the tip of the hook in such a way that there is a severe side-bending strain in addition to the lifting-strains caused by the chains hanging at the bottom of the hook.

Lubrication is often neglected because access to oil and grease cups is difficult.

The inconvenience attendant upon work performed on overhead-cranes and the failure to provide convenient platforms from which to perform such work, has caused much neglect of crane-repair and up-keep. One of the most noticeable defects is an increase in the amount of play and backlash that is allowed to develop in all parts of the structure, particularly in the gears. When this is excessive and the gears pound badly, the starting of the motor or its reversal from a raising to a lowering motion introduces strains on pinions, shafts, keys, and other parts sufficient to cause much damage. This wear is often due to the fact that adequate lubrication has not been furnished because access to the oil and grease cups has been difficult and the person responsible for maintaining the equipment has neglected to do his work because of the difficulty of getting at the places where it must be performed. The use of oil-cups or compression-grease cups serving all parts of the crane and so placed that they can be reached from the crane-walk-way is frequently advisable.

Red Cross Commandments in Rumania

"If you can't get a Ford, get a water buffalo.

"If you can't get a delousing station, build a brush hut.

"If you can't supply clothes, give out flannel pajamas.

"If you can't find lodging, sleep on the road.

"If you haven't hospital beds enough, make them from branches."

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The Human Element in Safety Work

In a paper presented at the recent meeting of the National Safety Council, on 'The Personal Element in a Safety Program for the Foundry,' M. F. Gartland, of the Marion Gray Iron Foundry, Marion, Indiana, said that there are three elements of hazard in even the best of foundries, namely: the equipment, the product, and the men. In considering the human element, it should be remembered that to a large extent a man is made or unmade by the things happening to him outside of his work-day life. A divorce suit in a local court may be more dangerous to the man involved than an open pit near his work-bench. A threatening landlord may produce more injuries in the plant than the worst hazard of equipment.

Taking up the particular types of men most likely to be injured, the first to be considered is the misfit. There are men in any foundry that do not belong there. They have been drawn into the work by circumstances and it is hard for them to break away. Not having interest in the work, they lack the incentive to become efficient workmen. They drag through the work without enthusiasm and leave when the whistle blows with a full quota of accidents piled up behind them. One way of dealing with such a man is to discharge him, but the labor shortage frequently makes this inexpedient. The man hired to take his place might be just as unsatisfactory. A better way is to transfer the man to some other department, to which he may be better suited. Experience shows that this works often enough to make it worth trying. No general rules can be laid down, but each case must be studied by itself. There are, of course, some men that are misfits anywhere, and these must be discharged for their own good and for that of their fellow-workers.

The next man that is a maker of accidents is the man whose mind is ill at ease. It is not so easy either to recognize or to deal with this type as with the misfit. He may be, when circumstances are ordinary, a careful and loyal workman, but under the weight of personal trouble, he loses his sense of proportion, and all thought of safety for himself or for others is crowded out of his mind. When a man works without thinking, we may be sure that he will soon make trouble for himself or for somebody working near him. Here again, no general remedy is possible. The man's personal problems must be met and solved. Every plant should have visiting nurses, social-service workers, or at any rate some one with common sense and good judgment and with authority to ride over every precedent and to break every rule of the plant if it is necessary to supply the one and only remedy for the worker that is in trouble. A dozen troublesome cases for which real remedies have been found and applied are worth more to a plant as a business asset than to have entertained the whole working force in royal style.

The next source of danger is the careless man. Such a man is more dangerous to a plant than a box of dynamite. We know that the dynamite will explode under certain conditions, but we can never tell what the careless man is going to do next. The fortunate thing about the careless man is that he can be educated both as an individual and *en masse*. We can appeal to him on the basis of loyalty to his family, and of the safety of those that work around him. Safety bulletins and other educational activities serve to enlighten the mass. Personal talks with the careless man by some member of the executive staff are probably the most effective. As with the misfits, on the rare occasions when a careless man is found to be incurable, he should be discharged.

Two other elements, not directly personal, but closely related to personal considerations, should also be mentioned. The first is environment. Environment is directly related to efficiency and efficiency is a half-brother to safety. The man who works at a rate of speed that is normal for him as an individual will have fewer accidents than he would if he worked a great deal faster or a great deal slower. The piece-worker, who, naturally, is interested in maintaining a high degree of personal efficiency, will have fewer accidents than the day-worker, who takes occasion to kill a block of time now and then. The one is keyed up to his normal pace with mind alert and with attention centered in his task, while the other man takes the pace that will keep him out of trouble with the foreman. His mind may be a blank and his attention may be focused anywhere but on his work. It is easy to see the relation that exists between these men and the accident record of the plant where they work.

Everything that has a bearing on the productive labor of men has also a bearing upon accident experience. Everything that takes the attention of men from their work will be reflected in the number of accidents, and everything that is done to improve working conditions will mean not only a higher rate of production but also a lower rate of injury. Even the buildings where men work have a bearing on this personal problem of safety. A building so constructed that men can constantly watch the street outside is a menace to the safety of the plant. When men watch the street they do not watch their work and this is productive of injury. Buildings should be well-lighted, to be sure, but the light should come from windows well above the level of the workman's eyes.

The second thing is proper instruction for the man newly hired. This is a more personal matter than that of environment. A man may be a good workman, even a master of his trade, but if he does not know our methods of doing work in our foundry he may cause any number of accidents to himself and others before he learns. No man should be turned loose alone on a job until he has learned all he can be taught about it. He should know all of its hazards and should be shown how his work is to be related to other work throughout the plant. He will work with more understanding and with a more sympathetic attitude of mind. These have a direct bearing on making him a safe and efficient workman.

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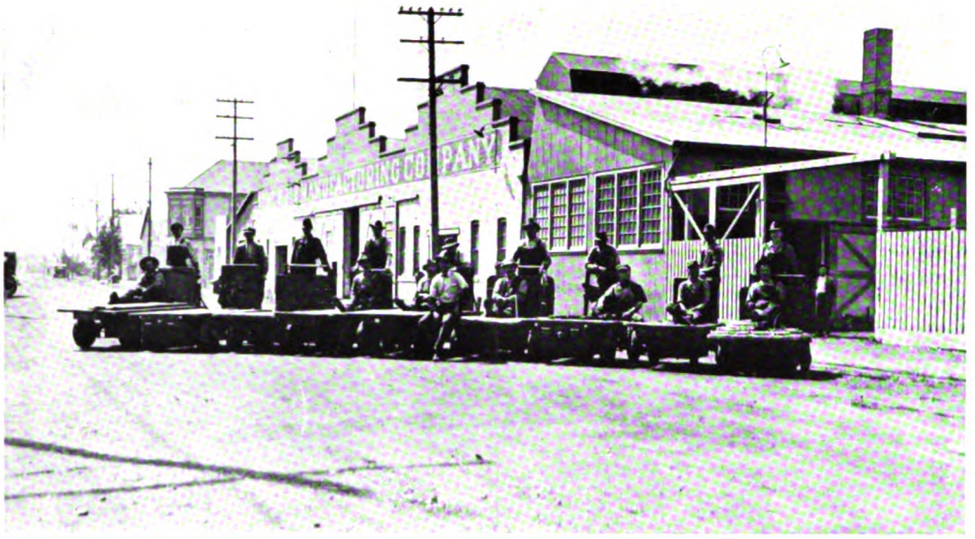

FIG. 1. NINE DORMAN TRUCKS WITH THEIR DRIVERS

Inter- and Intra-Departmental Handling of Material at the Holt Plant

The plant of the Holt Manufacturing Co. at Stockton, California, covers nine city blocks, 303 ft. square, besides parts of several others. During recent years the number of employees has varied between 1500 and 2800. Naturally, the transportation of material, both between departments and within each department is a question of considerable importance.

Materials received at the plant from outside are either unloaded directly from the cars to stock-piles, or else handled in Pierce-Arrow motor trucks of the usual design. Inter-department transportation is mainly done by two-ton Dorman electric trucks of the type shown in Fig. 1. Ten of these are now in use and five more have recently been ordered. The types of electric truck generally used around wharves, warehouses, etc., have been tried, but they failed to give satisfaction. This is mainly because the wheels were too small to operate satisfactorily during wet weather. The Dorman trucks, on the other hand, have wheels large enough to operate successfully during the wet season, and they are seldom in the repair-shop because of wheel trouble, or for any other reason. An effort is now being made to arrange for paving at least a truck-runway along the various streets, but it is probable that even if this is done, the Dorman trucks will still be found to be the most satisfactory. They have a small turning-radius, and run up and down the aisles and sharp

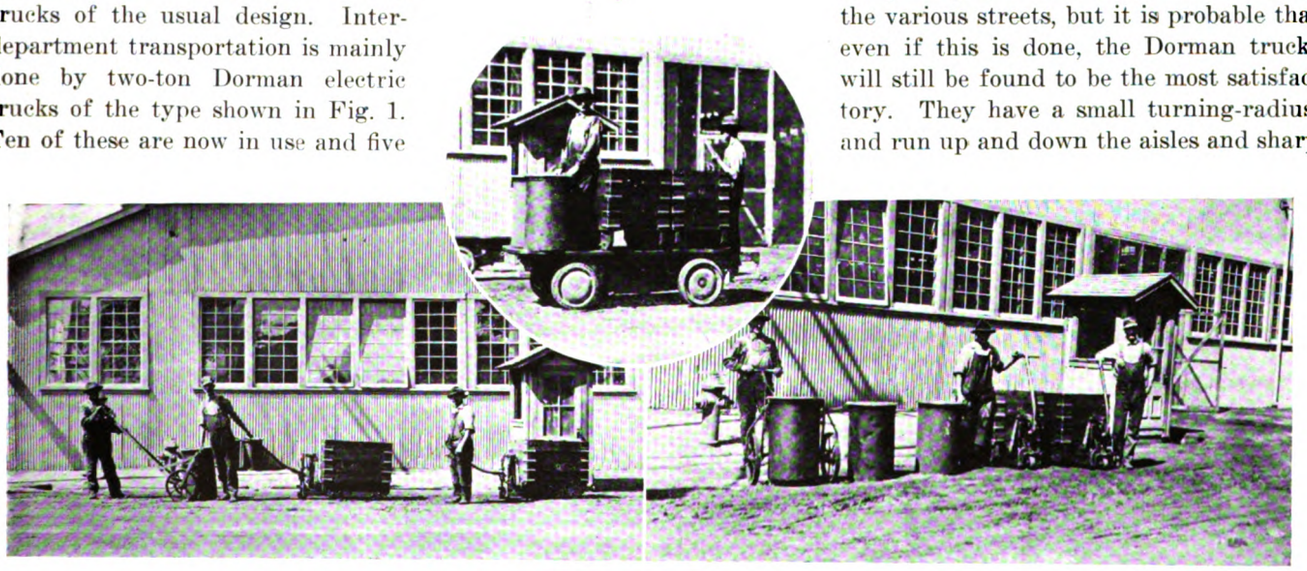

FIG. 2. BARREL-TRUCK AND TWO LIFT-TRUCKS LOADED WITH TRAYS. FIG. 3. BARRELS AND TRAYS ON DORMAN TRUCK.
FIG. 4. BARREL-TRUCK, LIFT-TRUCKS, AND EXTRA BARRELS

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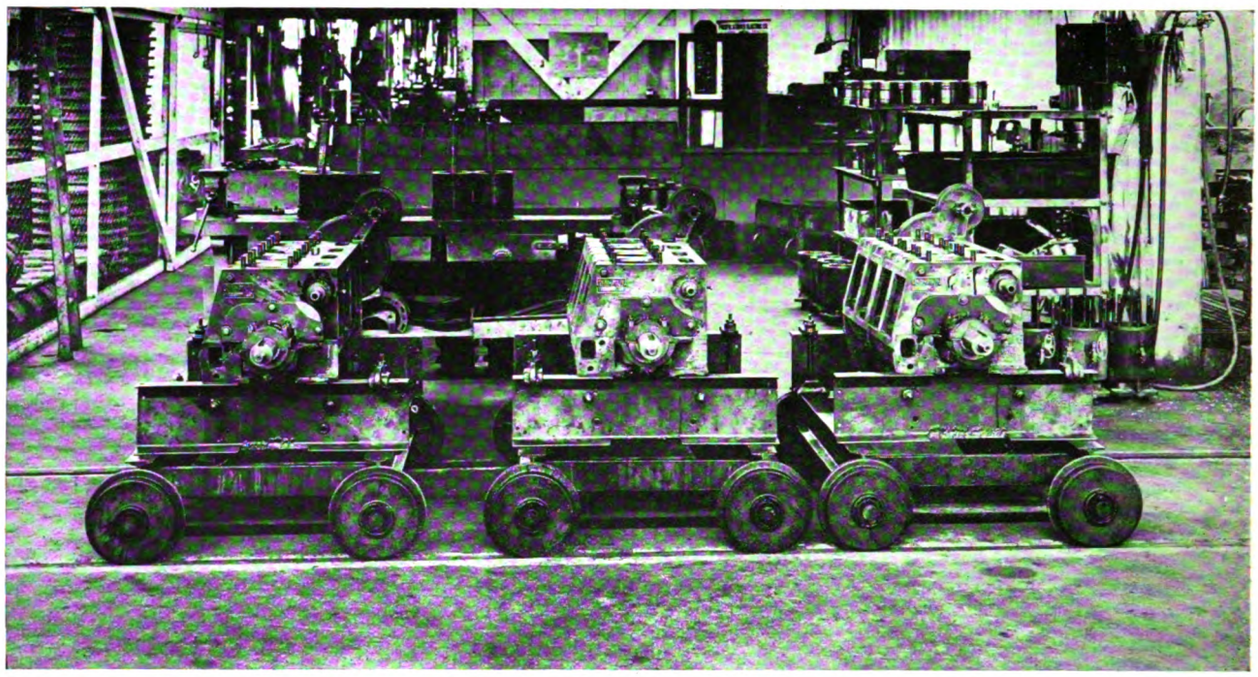


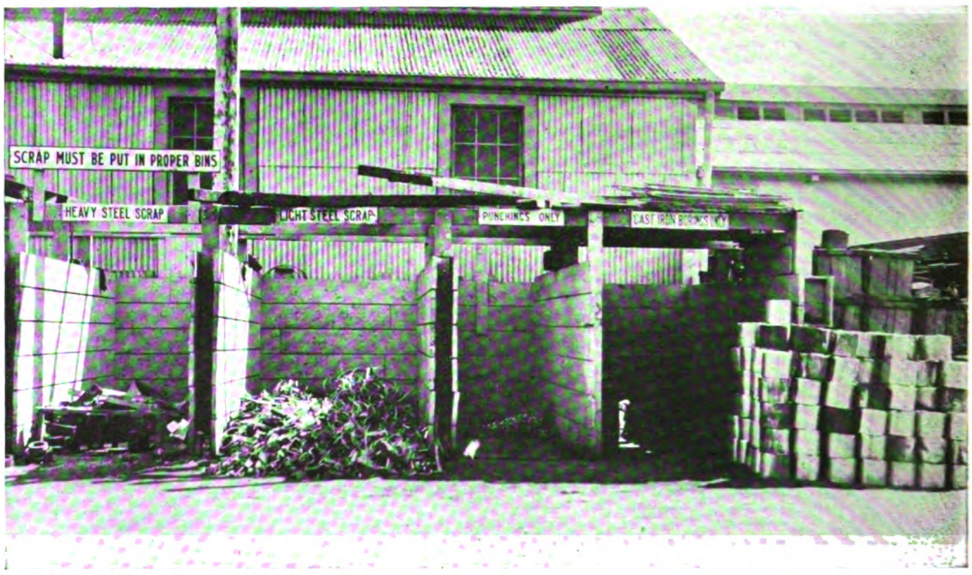
FIG. 5. ENGINES BOLTED TO I-BEAM FRAME OF TRUCKS FOR ASSEMBLING

turns in the machine-shop and elsewhere without difficulty. Where a load of material has already been placed on any of the smaller hand-trucks hereinafter described, the hand-truck can be hitched behind the electric truck and used as a trailer to save re-loading.

For handling small loads within the departments, which cannot be transported conveniently by the traveling-cranes, hand 'lift-trucks' of the type shown in Fig. 2 and 4 are used. They are particularly useful in moving the trays shown in Fig. 2, 3, and 4. The truck-body is run directly under the tray, which is then lifted off the ground by means of the jack-lift on the truck. These trays may be built to any height required and are used for holding all sorts of small materials, including pieces to be machines, etc. A man can deposit the un-machined pieces beside a lathe, then run his truck under a tray full of machined pieces and carry them to the next operation. Actual handling of material is thus reduced to a minimum. The trays are easily handled on the electric trucks also, as shown in Fig. 3.

For certain pieces of material, particularly in the machine-shop, a sheet-iron 'barrel' is sometimes used, and a special type of truck, shown in Fig. 2 and 3, is arranged so that the barrel can be readily swung on and off by one man. Other kinds of hand trucks are used for special purposes around the plant.

In the machine-shop, the shipping department, and in other parts of the plant where it can be arranged conveniently, the truck-runways are paved with creosoted wood blocks. These give a smooth surface, have good wearing qualities, and are easy on the men's feet.



PART OF SCRAP-STORAGE YARD. CANNED BORINGS AND TURNINGS ON RIGHT

A useful truck for the engine-assembling department is shown in Fig. 5 and 6. As will readily be seen, a frame of I-beams is bolted to the running-gear of the truck. The two pairs of I-beams each contain bolt-holes, in one pair corresponding to the width, and in the other

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to the length of the engine-frame. The engine is bolted to the beams and the work of assembling proceeds along one track, across to another by means of turn-tables, and thence into the testing department. The trucks are readily moved by hand along the rails. There are three sets of bolt-holes, corresponding to the three sizes of motors that the company manufactures. Should it at any time decide to manufacture engines of other sizes, it would be a simple matter to bore a few holes in the I-beams.

The routing of the electric trucks presents no small problem in itself. General routes have been arranged between the various departments, so that a truck going from the foundry to the machine-shop, or from the machine-shop to one or other store-room always follows the same route. This ensures the quickest route being taken, and also reduces the danger of collisions. It might also be stated that these routes are selected with

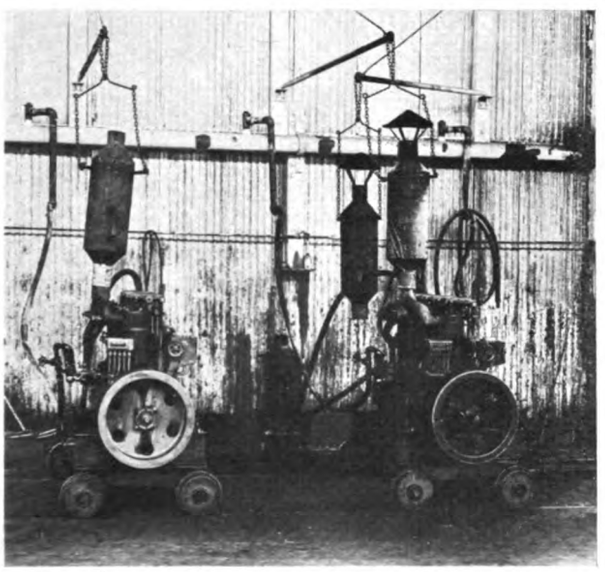

FIG. 6. ENGINES ON ASSEMBLING-FLOOR, ALMOST READY TO RUN INTO TESTING-ROOM

a view to minimizing the danger of accidents from collisions between trucks and pedestrians, even at the occasional sacrifice of the most direct route. The number of accidents from collisions is, however, almost negligible.

The actual train-despatching is done from the small office shown in several of the illustrations. This is connected by telephone with all parts of the plant. Each truck has a number and each department has a number. When truck No. 7, say, has delivered its load at No. 26, which is, say, a store-room, the truck-driver telephones the fact to the despatcher, who looks at his list and sees that there is a load to go from the machine-shop to the unit-assembly department. The truck-driver is then ordered to do this work. For some time it was customary to keep track of the work by means of a chart of the entire plant, using numbered pegs for the different trucks. This, however, has not been found convenient, partly on account of the difficulty of keeping such a chart up-to-date in a progressive plant. At present the records are kept on cards, which are filed at the end of each day. This has another advantage, since a record of the work is desirable, and this method supplies it, without the necessity of using the chart. That this system of despatching is effective and that the equipment in general is adequate, is shown by the general agreement among the various departments that the time lost because of delays in the transportation service is negligible.

Acknowledgment should be made to A. G. Lillybridge, assistant superintendent of the machine-shop block at the Holt plant, who combines with his other duties the superintendence of truck transportation, for co-operation in the preparation of this article.

A Foreman's Bonus and Its Effect on Accident Reduction

Certain industrial concerns, most of them in the steel industry, have adopted the policy of giving a bonus to foremen as a reward for the reduction of accidents in their respective departments. Lucian W. Chaney reports the results of an investigation of this practice in a recent bulletin issued by the U. S. Bureau of Labor Statistics. The investigation appears to have been confined to blast-furnaces, steel-works, and rolling-mills. The general procedure in applying such a bonus plan is as follows:

1. A careful study is made of the past experience of the several departments of the plants. From this, accident rates are determined representing that experience.

2. A foreman that fails to bring his accident rate as low as this rate receives no bonus. If he equals the base rate, he receives a certain sum per man under his supervision. This sum is increased in proportion to the degree to which he brings his rate below the base-rate.

3. The bonus is made large enough to furnish a real incentive. For example, a foreman in charge of 100 men might, under favorable circumstances, receive a bonus of as much as $200 per year.

After comparing accident records at plants that have such a bonus system with records at plants that have not, the following conclusions are stated:

1. A foreman's bonus for accident reduction will tend to reduce minor injuries considerably.

2. A foreman's bonus will not necessarily reduce the more serious accidents. If the desired results are to be obtained, the bonus must be re-inforced by vigorous application of other measures.

IF it will cheer you up any you may know that the money you spend for the war tax on your movie ticket and your soda-water may be deducted from your gross income in computing the amount you owe the Government. This ought to brighten the sky if you didn't know it before.—'Los Angeles Times.'

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Determining Charges for Automobile Repair Work

One of the biggest causes of trouble and complaint in the automobile-repair business is the ignorance of the automobile owner regarding mechanical work and the manner in which the shop is run. The usual method of basing the charge on the cost of the material and the mechanic's time is probably as fair as any, but it does not find favor with the owner. This is largely because he cannot find out what the job will cost him until he gets his bill. Then it is too late to do anything but 'kick'. When he is charged for a mechanic's time he often feels that a good mechanic did not work on his car. Recently an automobile owner remarked to a friend, who drove the same make of car, that he had just paid $9 for having his valves ground. The other man exclaimed, "Nine dollars! Why I had mine ground only last week and it cost me $11." The second owner thought he had been robbed and complained to the repair-man. As a matter of fact, the latter made no more money from him than he did from the $9 man, but finally, to avoid trouble, he made an adjustment that meant an actual loss on the job. The first thing an owner asks when he brings his car into a shop is "How much is the job going to cost," but he cannot find out exactly until he gets the bill. He does not buy anything else that way, and he feels that there is a possibility he has been cheated.

To overcome the trouble caused by the time and material method of charging, one repair and service shop in San Francisco has developed a system of flat charges to cover most of the repairs on the cars it handles. A list of fifty different repairs includes about 90% of all the jobs that come to the shop, and from the proprietor's experience with previous jobs he is able to make a flat price on nearly all work. Four years ago, when this system was started, an average of ten jobs of the same kind was taken to get the flat price. The preliminary and the final test and overhead are covered, of course, in the flat price. Every three months the prices are subject to revision from the information gained from the cost-records during that time. Experience has shown that a certain proportion of the total number of jobs come back and have to be done again. Sometimes the shop is responsible and sometimes it is not, but at any rate, the owner is unwilling to pay for having the job done again, no matter who is responsible. To allow for this correction work and for such adjustments as may be necessary during the first few days after the work has been completed, a fixed additional charge of 8% is made on all jobs.

This method has been found satisfactory. When the owner asks, "What will it cost me," he is told immediately, "This will cost you so much." Then he has the opportunity of saying either "Go ahead" or "I will not have the work done." If he says "Go ahead," he knows exactly what he will have to pay, and, as the manager of the shop says, the owner is even willing to pay a little extra if need be in order to learn the worst in advance.

Application to the Automotive Industry of Experience With Liberty Engines

In a paper presented at a recent meeting of the Society of Automotive Engineers, Harold F. Wood discussed the lessons learned from experience with the Liberty engine, and showed how these lessons can be applied in the manufacture of automobiles, motor-trucks, and tractors.

The best material for carbon-steel screw-machine parts is basic open-hearth steel having the following chemical composition: carbon, 0.15% to 0.25%; manganese, 0.50% to 0.80%; phosphorus, 0.045% maximum; sulphur, 0.075% to 0.15%. This material is more uniform and is nearly as free-cutting as bessemer screw-stock. It is sufficiently uniform to be used for unimportant carburized parts as well as for parts that are not heat-treated.

For transmission gears, resistance to wear is the most important quality. The Brinell hardness should be 512 to 560. The best steel for this work has the following composition: carbon, 0.47% to 0.52%; manganese, 0.50% to 0.80%; phosphorus, 0.04% maximum; sulphur, 0.045% maximum; chromium, 0.80% to 1.00%. The forgings should be heat-treated by normalizing at 1550° to 1600° F., cooling from this temperature to 1100° F. at the rate of 50° F. per hour and cooling from 1100° F. in either air or water. This will give a hardness of 177 to 217, which is the best range for machining. The finished gears are quenched in oil from 1540° to 1600° F. and then tempered in oil at 375° to 425° F. This gives the required hardness of 512 to 560.

For ring-gears and pinions the following composition is recommended: carbon, 0.10% to 0.20%; manganese, 0.35% to 0.65%; phosphorus, 0.04% maximum; sulphur, 0.045% maximum; chromium, 0.55% to 0.75%; nickel, 0.40% to 0.60%. This material should be de-oxidized by the use of ferro-vanadium or its equivalent. The pieces should be carburized at 1650° to 1700° F. long enough to give a case 1/32 to 3/64 in. thick and quenched directly from the carburizing heat in oil. They are then re-heated to 1430° to 1460° F. and quenched in oil. They are then tempered in oil at 375° to 425° F. The final quenching operation on a ring-gear should be made on a fixture similar to the Gleason press in order to reduce distortion to a minimum.

One of the most important facts demonstrated by the Liberty engine work was that a relatively cheap steel, properly treated, can generally be used with satisfaction in place of some of the more expensive steels with large amounts of alloying substances.

THE attention of investigators is called to the recently discovered violation of all cold-storage regulations as the result of the excavation of the snow that had completely buried a pre-historic Eskimo village.

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The Effect of Certain Elements on the Properties of Steel*

By N. J. Gebert

PURE iron has a tensile strength of about 45,000 lb. per square inch. By adding a few tenths of one per cent of carbon, the strength is increased to 60,000 lb. and with 1% addition to 125,000 pounds.

Carbon assumes different forms on heating and cooling and it is this factor that governs the heat treatment of steel to a considerable extent. When we take a piece of steel with a carbon content of 0.3% and heat it slowly, we find that about 1340°F. the temperature of the piece remains stationary for a time although the temperature of the furnace keeps rising. This is the first critical point called Ac1. As the temperature of the furnace increases, the temperature of the sample again rises uniformly until a temperature about 1430°F. is reached, when the sample once more absorbs heat. This is the Ac2 point. The third critical point, Ac3, is reached about 1460°F., and since this is the upper critical point, the temperature of the specimen will then rise uniformly without any more breaks in the curve. On cooling, this condition is reversed, that is, an evolution of heat takes place, causing a stationary or slightly increased temperature at points somewhat lower than the Ac points. There are as many critical points on cooling as there are on heating and these are called Ar3,2,1. As the carbon content is increased, these three critical points approach each other. When the carbon content is about 0.38%, there are but two points, the Ac1 and Ac2,3. When the carbon content is 0.85% we have one point, the Ac1,2,3.

Carbon assumes different forms on heating and cooling, and it is this factor that governs the heat treatment of steel to a considerable extent.

The heat treatment of the steel is as important a factor as the correct chemical composition. If we desire maximum softness with the smallest grain, the material must be heated just to or slightly above the Ac3 critical point. The greater the heat the larger the grain and, therefore, the temperature to which a piece of steel is heated should be regulated carefully. Any slow cooling from above the critical points can easily be detected in the resultant physical properties, particularly the ductility. For example; it was desired to obtain from a 0.30% carbon-steel, physical properties as follows:

If we desire maximum softness with the smallest grain, the material must be heated just to or slightly above the Ac3 critical point. The greater the heat, the larger the grain.

Tensile strength—63,000 to 72,000 lb. per square inch.
Elastic limit—32,000 lb.
Elongation in 5 in.—21%.

An anneal of 1550°F. (the temperature recommended for this steel) produced at a tensile strength and an elastic limit passing specification, but the elongation was only 16 to 20% in 5 in. Annealing temperatures from 1450° to 1650°F. were tried with the same low elongation. Accordingly, we annealed at 1250° to 1275°F. a sample of analysis:

	%		%
Carbon	0.30	Phosphorus	0.018
Manganese	0.70	Sulphur	0.026
Silicon	0.16		

for 8 to 10 hours, which gave an elongation of 21.4 to 24.0%, according to the size of the section, without materially affecting the elastic limit and tensile strength, which were 36,000 and 60,000 lb., respectively.

The best steel to carburize is that which contains less than 0.25% carbon. As the carbon gets over 0.25% it is more and more difficult to get a good structure of the core together with a well hardened case until we reach about 0.40%, when it is impossible to get a good refined grain in the core without overheating the case. In the double quenching, following the carburizing, the first heat 1500° to 1600°F. is over the critical point of the core and, on quenching, the smallest possible grain is obtained. This heat is too high for the case and so to refine the case, the material is re-heated to 1360° to 1430°F. and quenched. This second quench, while over the critical point of the case, is not over the critical range of the core and, therefore, acts as a draw for the core, refining and toughening it. If the carbon content of the core is over 0.40%, this second heat is above its critical point and instead of acting as a draw, it merely enlarges the grain, making the product brittle and worthless for most uses. If the material were heated below the critical point of the core, it would also be below the critical point of the case and, therefore, the case would not harden file-hard. A test illustrating that this second quench acts only as a draw to the core and that the method of cooling makes no material difference, was conducted on steel of analysis:

	%
Carbon	0.20
Chromium	1.50
Nickel	3.50

Several test samples were carburized and then quench-

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ed from 1500°F. in oil. The second quench was 1400°F., one in oil and one in water. The case was ground off and pieces of the core were tested and showed

Tensile strength—230,000 lb.
Reduction of area—50%.

There was no difference in the properties of the core between the ones hardened in oil and the ones hardened in water.

As the carbon is increased, the steel is capable of greater hardness with a corresponding loss of ductility. When the carbon content is 0.85% (the eutectic composition) we have a uniform mass of pearlite, which is the ideal analysis of tool-steel. Below 0.85% there is an excess of soft ductile ferrite, while over 0.85% there is excess cementite (iron carbide). According to Osmond, cementite is the hardest (but most brittle) constituent in a steel, having a tensile strength of barely 5000 lb. with no ductility. The primary factor in the heat treatment of steel is whether or not the carbon or more probably the carbide is in a state of solid solution. This is governed by either the mechanical treatment of the steel, the rate of temperature change, or a combination of the two.

The primary factor in the heat treatment of steel is whether or not the carbon, or more probably, the carbide is in a state of solid solution.

The influence of variations in the carbon content on the physical properties of steel under the treatment they require is shown in the following table:

Grade	Carbon, %	Rolling and forging temp., F.	Annealing temp., F.	Hardening temp., F.
2	0.16 to 0.25	1900°	1500° to 1525°	1525°
3	0.26 to 0.35	1900°	1500° to 1525°	1525°
4	0.36 to 0.45	1900°	1500° to 1525°	1525°
5	0.46 to 0.55	1850°	1475° to 1500°	1500°
6	0.56 to 0.65	1850°	1450° to 1475°	1480°
7	0.66 to 0.75	1850°	1425° to 1450°	1470°
8	0.76 to 0.85	1800°	1400° to 1425°	1450°
9	0.86 to 0.95	1800°	1375° to 1400°	1440°
10	0.96 to 1.05	1800°	1375°	1430°
11	1.06 to 1.15	1800°	1375°	1420°
12	1.16 to 1.25	1800°	1375°	1400°

The physical tests on each of the above grades, after annealing, would be about as follows:

Grade	Maximum strength, pounds per sq. in.	Elastic limit, pounds per sq. in.	Elong. in 2 in., %	Reduction of area, %	Brinell hardness
2	55,000	30,000	40	60	110
3	65,000	35,000	34	58	130
4	70,000	38,000	32	56	140
5	70,000	38,000	30	55	150
6	73,000	40,000	28	52	150
7	80,000	42,000	26	50	160

The remaining grades from 8 to 12 will all show about the same physical properties if well-annealed, being approximately as follows:

Maximum strength, pounds per square inch	80,000 to 90,000
Elastic limit, pounds per square inch	40,000 to 50,000
Elongation in 2 in., per cent	20 to 30
Reduction of area, per cent	40 to 60
Brinell hardness	160 to 185

It is impossible to give any specific definite physical properties as they depend entirely upon size and section, how cooled, and whether forged or rolled, etc.

The physical properties on each of these grades, after heat-treatment, would be about as follows:

Grade	Treatment	Tensile strength lb., sq. in.	Elastic limit lb., sq. in.	Elong. in 2 in., %	Red. area, %	Brinell hardness
2	1550°F. oil, 900°F. draw	75,000	42,000	26	65	130
3	1550°F. oil, 900°F. draw	82,500	50,000	23	61	160
4	1525°F. oil, 900°F. draw	94,000	63,000	21	52	200
5	1500°F. oil, 900°F. draw	110,000	75,000	17	45	230

When you get to 0.60% carbon, the steels are generally used in a hardened condition. For example: a 0.60 to 0.70% C. steel is a die-stock analysis and is hardened and then drawn just enough to relieve strains.

The higher carbons, over 0.70%, will harden file-hard and are used for tools, drills, and similar articles. There are one or two cases, such as springs, where a 1.00 to 1.25% carbon steel is used in the heat-treated condition (1500°F. oil and 800° to 1000°F. draw).

Manganese is added to steel for three general purposes:

1. To take up or reduce the oxide in the steel.
2. To combine with the sulphur and prevent the formation of iron sulphide.
3. To increase the tensile strength and hardness.

Manganese alone is a comparatively weak deoxidizer, but has a much stronger action if some other deoxidizer like silicon is present. In general, about four times as much manganese is needed as there is sulphur present, as the manganese does not always catch all the sulphur. Manganese as affecting the physical properties of steel seems to have been given less attention by manufacturers than any other element. On annealed steels, up to about 2%, each 0.01% manganese increases the tensile strength by about 160 lb. per square inch. It slightly increases the reduction of area and lowers the elongation. From 2.50 to 7% manganese makes steel extremely brittle, but above 7% this effect disappears and we again have a useful alloy. An 11% alloy has a wide range of uses, for crossing-frogs, rails, gears, etc. It is usually finished by grinding, as it is almost impossible to machine. As cast it is quite brittle, and to remove this it is quenched from about 1830°F. in water. The properties of the treated material are:

Tensile strength—90,000 to 110,000 lb. per square inch.
Elongation in 2 in.—33%.
Brinell hardness—200.

Manganese, when added to steel, has the effect of lowering the critical range; 1% of manganese will lower the upper critical point 60°F. In this respect, manganese is twice as powerful as nickel, as 1% nickel lowers the critical point from 25 to 30°F. Many companies have assumed that because a piece of steel containing 1 to 2% manganese cracked on drastic water-quenching, that the steel was brittle; when the steel should not have been handled in that manner. Manganese refines the grain considerably and this fineness leads to a better quality in general if the material is properly treated. The rapidity of cooling as compared with straight carbon-steel must be lessened, also the temperature from which it is quenched, because of the lowering of the critical points. This rapidity of cooling may be lessened by substituting (1) oil for water quenching, or (2)

Manganese refines the grain considerably, and this fineness leads to a better quality in general if the material is properly treated.

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air cooling for oil quenching, or (3) quenching in water covered with a film of oil, or (4) withdrawing the quenched object from the quenching bath after a predetermined length of time. It is by enabling us to lessen the carbon content, or the rapidity of cooling or both, that manganese-steel may be employed to lessen the danger of cracking.

In comparing the properties of manganese and nickel steels, we find (taking reduction of area as a measure of toughness) that in the annealed condition, steel containing 1.50% manganese is fully as tough as and is stronger than a 3.50% nickel steel. The actual physical properties of three steels are tabulated in the following table; a carbon steel of 0.34% carbon; a manganese steel of 0.34% carbon, 1.60% manganese; and a nickel steel of 0.34% carbon, 3.50% nickel:

Grade steel	Elastic limit, lb. sq. in.	Tensile strength, lb. sq. in.	Elongation, %	Reduction of area, %	Brinell hardness
Carbon	36,600	67,250	32.0	51.0	120
Nickel	55,000	81,850	31.2	59.0	153
Manganese	61,150	87,850	29.9	58.5	150

On heat treating, the manganese-steel has relatively the same tensile strength as the higher nickel-steels, but the toughness is considerably reduced. For instance, after quenching from above the critical point in water and drawing both at 1100°F., the nickel-steel shows a reduction of area of 65%, whereas the manganese steel has a reduction of only 53%.

Briefly summarizing, we get the following: While the manganese effect upon a steel that has not been treated is to increase the toughness slightly, its effect upon a heat-treated steel is the reverse. In the case of nickel, the effect on a piece of untreated steel is practically zero, while in the heat-treated condition, nickel increases the toughness decidedly. An untreated steel of 1.50% manganese is fully as tough as and is stronger than a 3.50% nickel-steel.

The principal use of silicon is to eliminate the gases in the molten steel. It has a great affinity for oxygen and carries it off in the slag, whether in the form of gases, oxides, or dissolved oxygen. This prevents the formation of blow holes and thus makes the steel better able to withstand wear or crushing from continual pounding:

The principal use of silicon is to eliminate the gases in the molten metal.

The silicon steels can be divided into two general classes:

1. Silico-manganese steel for springs and gears.
2. An almost carbonless iron containing about 2.75% silicon for electrical purposes.

An analysis of silico-manganese steel for springs as commonly used in this country is:

Carbon—0.55%.

Silicon—1.90%.

Manganese—0.70%, which will give the following physical properties:

	As received	Heat treated
Elastic limit, pounds per square inch	85,000	184,000
Tensile strength, pounds per square inch	135,000	215,000
Elongation in 8 in., per cent	17.5	6.0
Reduction of area, per cent	32.5	22.0
Brinell hardness	275	412

About the only feature favoring its use is its lower cost, but its great disadvantages are: great sensitivity to heat treatment, and feeble resistance to shocks. The temperature limits for quenching are narrower than for most alloy steels and the steel responds too quickly to variations in heating and cooling.

In the second group, we have a steel for electro-magnets and for electrical purposes demanding high magnetic permeability and low hysteresis. It is the only single element which for this property combines, deoxidation, graphitization, increased grain size, and increased electrical resistance. The analysis and heat treatment recommended is: Silicon, 2.75%, with carbon, manganese, and all other impurities as low as possible. Heat to 1950°F., cool quickly, re-heat to 1380°F., cool very slowly, and in some cases re-heat to 1475°F. and cool slowly.

Sulphur does not add to the strength of steel, but has a tendency to cause red shortness or brittleness at red heat. There should always be sufficient manganese present to take care of the sulphur and prevent the formation of iron sulphide, as manganese sulphide is not nearly so harmful to steel as iron sulphide. The sulphur should not exceed 0.10% in any steel, but sulphur up to that amount shows relatively no effect on very low carbon steels. In tool steels or where the steel must often be heated and cooled, the sulphur should not be higher than 0.03% and as much lower as possible.

As the general characteristics of phosphorus on steel are so well known, I will limit myself to a table of its good and bad effects on steel, as phosphorus is undoubtedly the most injurious element that is found in steel.

1. Decreases the ductility of steel as shown by the reduction of area and the elongation.
2. Stands up poorly as tested under rotary or alternating vibration.
3. Has low shock-test, particularly at low temperatures.
4. Increases the tendency toward segregation.
5. Causes coarse crystals to form. This tendency is increased with the addition of carbon, therefore high phosphorus is not nearly so harmful in machine steels as in the higher carbon-steels.

In the rolling-mill, phosphorus does not show any bad effect (below 0.135%), as the heat under which steel is worked seems to overcome this. There are two chief uses for which phosphorus can be favorably added:

1. For third rails in electric railway, as phosphorus increases the hardness considerably without decreasing the electric conductivity.
2. In reducing the melting-point in cast-iron, making the metal more fluid and prolonging the period of solidification, making a high phosphorus content valuable for fine art-castings where every crevice must be filled.

On low-carbon steels up to 0.35% and chromium 0.50%, no additional properties are found that cannot be obtained by a higher carbon content except for case-hardening, where the addition of chrome increases the rate of penetration of the carbon over that of a straight carbon-steel. Chrome-steel is more sensitive to prolonged high heat and, therefore, case-carburized articles

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must be double quenched. In many cases both the quenches may be in oil, since chrome-steel is capable of greater hardness and also greater depth of hardness. Chromium refines the grain remarkably and prevents the development of the so-called crystalline structure. It raises the critical points and also makes the changes in the critical ranges take place much more slowly, and thus gives steel the power to acquire hardness without increasing the brittleness to such a degree as increased carbon would. This degree of hardness is, within certain limits, dependent on the carbon content, as chromium alone will not harden iron. Toughness is also conferred by the degree of fineness of the structure, which is a characteristic of chrome-steels, thus increasing the tensile strength and elastic limit without a noticeable loss of ductility. This makes it valuable in parts requiring great resistance to wear.

Chromium refines the grain and increases hardness and toughness.

Of the high-carbon chromium-steels there are but four different analyses used to a large extent, for which analyses, annealing temperatures, physical properties, etc., are listed in the following table:

Grades	Carbon, %	Manganese, %	Silicon, %	Phosphorus, %	Sulphur, %	Chromium, %
1	0.95 to 1.10	0.30 to 0.50	not over 0.25	0.025	0.025	1.10 to 1.30
2	0.95 to 1.10	0.30 to 0.50	not over 0.25	0.025	0.025	1.30 to 1.60
3	1.05 to 1.20	0.30 to 0.50	not over 0.25	0.025	0.025	1.10 to 1.30
4	1.05 to 1.20	0.30 to 0.50	not over 0.25	0.025	0.025	1.30 to 1.60

All four of the above analyses will give practically the same properties on hammering, pressing, or rolling.

For hammering, forging, or pressing, ingots or billets should be uniformly heated to 1800 to 1900°F. For rolling, billets should be heated to 1700 to 1800°F., depending on the size and reduction to take place. Steel of this analysis, when cold, should never be placed in a hot furnace, but should be pre-heated.

If the steel has been hammered, forged, or pressed at a high heat and cooled slowly, it is necessary to give it a double anneal. The first anneal puts the steel in good condition and the second anneal makes it soft and in the best condition for machining and hardening:

This double anneal consists of the following:

1. Heat uniformly to 1650°F., hold six hours to make sure that it is uniformly and homogeneously heated, then cool in the air as quickly as possible.

2. Heat slowly and uniformly to 1375 to 1400°F., hold ten hours at heat, then cool slowly, not more than 10°F. per hour for the first 30 hours.

If the bars have been rolled carefully, finished at a low heat, and properly and quickly cooled, the material can be annealed in one heat by heating uniformly to 1375 to 1400°F. and cooling slowly.

If it is desired to anneal the material without scaling, it should be packed in charcoal ($\frac{1}{4}$ new and $\frac{3}{4}$ old), heated uniformly to 1375 to 1400°F., then cooled slowly in the furnace.

If annealing has been properly carried out, the material of this analysis will have a Brinell hardness of about 170 and will show the following characteristics:

Elastic limit, pounds per square inch	53,000
Tensile strength, pounds per square inch	90,000
Elongation in 2 in., per cent	32
Reduction of area, per cent	60
Brinell hardness	170

In hardening these grades, a temperature of 1400 to 1500°F. should be used, depending upon the size and section, quenching in water, then drawing back to 350° F. to relieve hardening strains. If it is desired to harden small thin sections, an oil quenching-bath should be used and the material heated to 1450 to 1500°F., depending on the size and section. Work should then be drawn at 350°F. as in water quenching.

As we increase the chromium, the critical points are retarded more and more until the chromium content is 5 to 6%, when the critical points are retarded to such an extent as to give the same hardness when quenched as when air-cooled. Therefore heat treatment of this grade of steel has little influence except perhaps to refine the grain. On account of these characteristics, these steels are little used, except for special tool-steels. When the chromium content approaches 10 to 14%, we have a stainless steel, which will resist the action of dilute acid, salt, water, etc., for days. An analysis of a satisfactory steel of this character is: carbon, 0.25%; chromium, 10.50%; which when quenched from 1800°F. in oil, and drawn at 850°F. gives us the following physical properties:

Elastic limit, pounds per square inch	220,000
Tensile strength, pounds per square inch	225,000
Elongation in 2 in., per cent	14.0
Reduction in area, per cent	50.0
Brinell hardness	430

In order to bring out the full effects of the chromium for heat treating, this steel is usually alloyed with such elements as nickel and vanadium, which alloys will be discussed under their respective headings.

Nickel was one of the first of the now common alloys used in steel manufacture. It responds to heat treatment readily, but its changes proceed slowly and, therefore, it must be heated slower and held longer at heat than ordinary steels. Great care must be exercised in its manufacture because of seams and a tendency to assume a laminated structure.

The elastic limit and tensile strength are increased by the addition of nickel, the reduction of area altered but little, while the elongation is decreased appreciably. A heat-treated nickel-steel, while having a lower reduction of area and elongation than a correspondingly heat-treated steel without the nickel, has more than enough increase in strength to make up for it; or with a given strength, the nickel-steel will have greater toughness. As we increase the strength of the nickel alloy (heat treated or not) the loss of reduction of area and elongation is far less than the loss secured when the strength is increased by increasing the carbon content. In short, nickel, as a strength giving element, is not accompanied by such a loss in toughness as are carbon steels. Nickel decreases the rate at which steel will absorb carbon in the carburizing process, but since a nickel-steel is not as susceptible

With a given strength, a nickel-steel will have greater toughness than an ordinary carbon-steel.

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to prolonged high heat as a carbon or a chromium steel, it makes a good steel for casehardening, providing the carbon content is correct, which should be below 0.25%. The material after carburizing should be double quenched, but because the nickel lowers the critical point, the second quench may be low. On a small section of case-carburized 3.50% nickel-steel (the usual commercial alloy) this second temperature may be as low as 1300°F., quenching in oil.

To bring out the full effects of nickel, the material should always be heat treated, as there is relatively little advantage in adding nickel if the steel is to be used in the annealed state. The effects of heat treatment on the properties of nickel and machine steel of the same carbon content can be found in the following table:

To bring out the full effects of nickel, the material should always be heat treated.

	Nickel steel	Machine-steel
	%	%
Carbon	0.35	0.36
Manganese	0.63	0.57
Phosphorus	0.010	0.017
Sulphur	0.030	0.049
Nickel	3.59	....

Nickel-Steel

Treatment	Elastic limit (Lb. per sq. in.)	Tensile strength (Lb. per sq. in.)	Elongation in 2 in. (Per cent)	Reduction of area (Per cent)	Brinell hardness
Annealed	60,450	95,800	27.0	54.0	170
1500°F. oil, 0°F. draw	241,850	277,550	7.25	16.1	445
1500°F. oil, 600°F. draw	175,450	208,650	11.0	43.9	375
1500°F. oil, 900°F. draw	146,030	163,030	13.2	45.9	316
1500°F. oil, 1200°F. draw	82,325	109,575	25.3	63.8	202
1500 F. oil, 1400°F. draw	62,300	99,950	26.0	54.8	185

Machine-Steel

Annealed	40,950	76,750	28.0	42.7	125
1500°F. oil, 0°F. draw	82,675	122,775	13.7	31.0	245
1500°F. oil, 600°F. draw	75,075	114,375	16.0	31.3	228
1500 F. oil, 900°F. draw	70,750	113,000	16.5	32.1	212
1500°F. oil, 1200°F. draw	59,125	92,400	23.7	51.0	170
1500°F. oil, 1400°F. draw	47,600	81,700	25.0	39.6	146

The material was annealed thoroughly before treating.

An addition of 3 to 4% nickel will prolong the life of steel in resisting stresses six or seven times. Even up to 5% this ability to withstand shock increases and also the dynamic strength increases. With the higher nickels, the structure is martensitic, in fact, for steel with 0.20% carbon with 15% nickel the structure is entirely martensitic.

The higher percentages 30 to 35% are used for valve-seats, valve-stems, and valve-heads, as the alloy is a poor conductor of heat and is particularly free from any tendency toward corrosion of pitting.

Vanadium added to steel increases the elastic limit and tensile strength, the former more than the latter. It is also used where great dynamic strength, resistance to vibration, impact, and torsional strains and stresses are needed. It makes the micro-structure denser and raises the critical point so that this type of steel must be hardened at a higher heat than a straight carbon-steel. In the vanadium-steels the elastic limit closely approaches the tensile strength with slight decrease in the elongation and reduction of area as shown in the comparison of a vanadium-steel and a straight carbon-steel of the same carbon content.

Vanadium is used where great dynamic strength, resistance to vibration, impact, and torsional strains and stresses are needed. It also acts as a cleanser.

	No. 1	No. 2
Carbon, per cent	0.27	0.26
Manganese, per cent	0.55	0.42
Vanadium, per cent	...	0.23

No.	Treatment	Elastic limit	Tensile strength	Elongation in 2 in. (Per cent)	Reduction (Per cent)
1	1652°F. oil, 1000°F. draw	49,910	80,470	32.0	65.0
2	1652°F. oil, 1000°F. draw	70,280	96,770	25.0	59.0

One of its peculiarities is that it does not render the steel more sensitive to prolonged high heat. This is the contrary to what we would expect from the pearlitic nature of the alloy. Vanadium also cleanses the molten material from oxides and nitrides and, therefore, has a duofold use. The full usefulness of vanadium is not obtained unless it is alloyed with another element, such as chromium or used in a ternary or quaternary alloy.

The properties given by steel alloyed with chromium or with nickel were good, but with just enough disappointment to warrant the search for better alloys. The natural development of chrome-nickel steel followed and it seems that the nickel intensifies the physical properties of the chromium and the chromium has a similar effect on the nickel.

For casehardening, chrome-nickel steels give very good results. The carbon is readily taken up in this combination, and for that reason it is preferable to the straight nickel-steels. The most suitable ratio for the alloys seems to be: roughly 2½ parts nickel for 1 part chromium, though good results have been obtained by the use of other ratios. As in all steels, the carbon content must be considered.

Chrome-nickel steel is easily treated and controlled and assumes an endless gradation of properties varying with the changes in treating conditions. Its superiority over the straight carbon steels of the same carbon content is due to its greater hardness, resistance to wear, greater tensile strength, and elastic limit without a corresponding loss in ductility, and its great resistance to shock. Some steel companies have found difficulty in forging this steel, but this is mainly because it is difficult to weld and, therefore, is apt to develop laps and seams.

Chrome-nickel steels have greater hardness, resistance to wear, tensile strength, elastic limit, and resistance to shock than carbon-steels without a corresponding loss in ductility.

It would be impossible to mention all the grades of chrome nickel-steel, so I have listed five of the most used steels commercially, ranging from a casehardening steel to the highest grade of the alloy.

	Carbon (Per cent)	Manganese (Per cent)	Silicon (Per cent)	Phosphorus (Per cent)	Sulphur (Per cent)	Chromium (Per cent)	Nickel (Per cent)
1	0.20 to 0.30	0.40 to 0.60	0.25	0.025	0.025	1.25 to 1.75	3.25 to 3.75
2	0.30 to 0.40	0.40 to 0.60	0.25	0.025	0.025	1.25 to 1.75	3.25 to 3.75
3	0.40 to 0.50	0.40 to 0.60	0.25	0.025	0.025	1.25 to 1.75	3.25 to 3.75
4	0.20 to 0.30	0.40 to 0.60	0.25	0.025	0.025	0.50 to 0.80	1.25 to 1.75
5	0.30 to 0.40	0.40 to 0.60	0.25	0.025	0.025	0.50 to 0.80	1.25 to 1.75

All the above grades can be forged or rolled at practically the same heat, about 1800°F. The temperature of the steel while being forged should never be under 1500°F. If the forging should begin to get cold, it should be re-heated.

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Grade	Annealing temperature
1	1340°F.
2	1340°F.
3	1360°F.
4	1340°F.
5	1360°F.

When properly annealed the above grades will show the following physical properties:

Grade	Elastic limit	Tensile strength	Per cent Elong. in 2 in.	Per cent Reduction of area	Brinell hardness
1	52,000	84,000	36	62	170
2	58,000	90,000	26	60	175
3	60,000	95,000	22	52	180
4	35,000	70,000	30	60	160
5	38,000	75,000	28	55	165

When heat treated, grades will show the following physical characteristics:

Grade	Treatment	Elastic limit	Tensile strength	Elongation, %	Reduction area, %	Brinell hardness
1	1550°F. oil, 900°F. draw	140,000	166,000	15	54	540
2	1525°F. oil, 1000°F. draw	148,000	165,000	15	52	320
3	1550°F. oil, 900°F. draw	159,000	201,000	12	39	402
4	1550°F. oil, 900°F. draw	148,000	166,000	14	53	332
5	1550°F. oil, 900°F. draw	162,000	180,000	12	45	370

Grades 1 and 4 are excellent for case-hardening purposes, giving an excellent refined wearing-surface with a tough core when hardened in oil.

Chrome-vanadium is virtually at the head of commercial alloy steels and it owes this prestige to the wide range of physical properties that can be developed by proper heat treatment. Chrome-vanadium alloys with iron in all proportions and affects the physical properties depending upon the proportion of chromium and vanadium present, and, as usual, the correct proportion of carbon must be used. It makes a good casehardening-steel, giving a glass-hard surface and a tough core. For this grade of steel the carbon content should be kept below 0.20%.

This combination increases practically all the good qualities of the steel such as dynamic strength, resistance to wear, increased hardening power, lack of brittleness, etc. In the cast material it tends to produce purity, soundness, and homogeneity of the metal. It raises the critical point of the steel and widens the temperature limits from which this steel may be quenched. A simple quenching and drawing treatment is sufficient for general purposes to effect complete refinement and hardening and this simplicity of treatment ensures a high-grade product under ordinary commercial conditions.

WHEN they were organizing the American Legion there were some heated debates on various organization points. One delegation had a membership idea that it wanted to put through. The majority turned it down on the ground that it was un-American. That was too much for one returned veteran. He came up on both feet with a roar.

"Do I understand," he demanded, waving both arms, "that those of us that went across have died in vain?"

He was assured that such was not the case.

"Well, that's all I want to know," he said. "If I thought I had given up my life without result I would rise up in my grave!"

Americanization and the Industries

Speaking at the recent meeting of the National Safety Council, H. T. Waller, formerly educational director for the B. F. Goodrich Co., said that Industry can do more for the promotion of Americanization than any other single agency. In fact, Industry must do more, for it is to the best interests of Industry that it should be done. The type of community in which a man lives determines more than we now realize the type of work that he produces. There is, therefore, a compelling economic force that determines Industry's place in this great problem.

Today we are facing the problem of a great labor shortage. The fact that foreign labor is returning to Europe is a natural thing, but if Industry and the community had paid special attention to establishing a sympathetic intelligent point of contact with foreign labor, the result would have been the establishing of permanent homes in this country by the foreign laborer, to a much greater degree than has been the case. Only in so far as we are able to establish this personal contact are we going to be able to stabilize labor. Industry must, therefore, take a position of leadership in the problem of Americanization, and where community educational forces do not recognize their responsibility for adult education, then Industry must and can take the leadership, and furthermore must see to it that there is a change in attitude on the part of the educational leadership in such a way as to meet the needs of the community they are serving. Force, compulsion, and paternalism should, however, be shunned. We do not want American citizens as a result of compulsion.

Safety work is an accepted part of industrial necessity throughout this country. Just what relationship the work among the foreign-speaking employees bears to the safety problem is comparatively easy to analyze. Every safety engineer will agree that the best safety-device known is a careful workman. Careful workmen are an impossibility if they are unable to understand instructions, both verbal and written. Only as every employee is able to understand and read warnings and instructions relative to dangerous machines is it possible to reduce the fearful fatality list, which is now a fact in our industrial life.

Industry must then supply leadership, money, and co-operation in the work of Americanization. The leaders of Americanization also must take their position with the leaders of direct production, working with them in close co-operation in order that there may be developed an industrial life based upon sympathetic understanding and mutual helpfulness.

A MOTORCYCLIST, hot, goggled, dusty, and hatless, stopped at a wayside inn for refreshments and ordered doughnuts. "Two washers for a nut!" cried the waiter on his way to the kitchen.—Everybody's Magazine.

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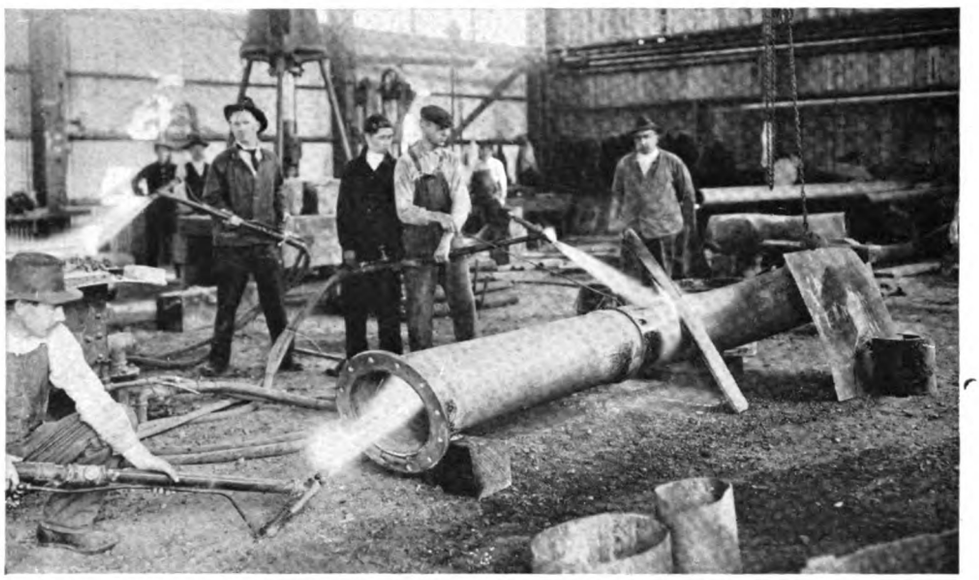
City Gas in the Shipyards

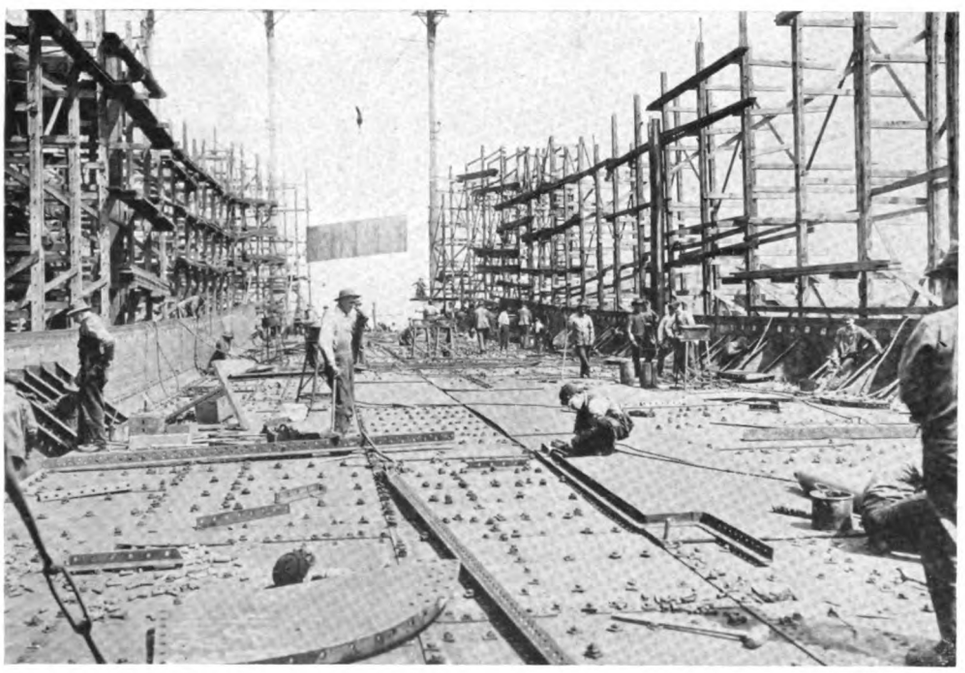
The use of ordinary gas for rivet-heating and other shipbuilding operations in the East-Bay yards is described in a recent number of the 'Pacific Service Magazine' by J. J. Mulgrew, of the industrial gas department of the Pacific Gas & Electric Co. While gas was originally adopted in pre-armistice days, when cost was a secondary consideration, and getting the work done was the principal object, a considerable saving in cost has also been obtained.

Crude oil and coke are the fuels generally used for rivet-heating furnaces, and in this locality, before the introduction of gas, oil was used almost exclusively. There were many disadvantages connected with its use. It had to be carried in cans to the heaters, which necessarily are placed close to the work. Some of the oil is spilt on the way and more is spilt in filling the heater-tank. This increases the risk of fire and accident, compels the men to move cautiously to avoid spilling, and necessitates the employment of a considerable number of men to carry the oil and also to clean up the spilt oil. Gas has none of these disadvantages.



GAS-TORCH HEATING COPPER PIPE AT THE MOORE YARD

Another advantage of gas over oil or coke is the prevention of scale, which frequently forms on a rivet when either of the two latter fuels are used. When this scale drops off, the rivet does not fit tight, and has to be taken out. Gas-heated rivets seldom give any trouble on account of scale. They are also comparatively free from pitting or overheating. Oil-heating is a little quicker than gas-heating, but, if necessary, this disadvantage may be overcome by building a larger gas fire-box.



GAS RIVET-HEATERS AT THE HANLON YARD

There are three types of rivet-heaters in use, the most common weighing about 200 lb. The fire-box is of plate-steel lined with firebrick, and the gas is connected by a heavy $\frac{3}{4}$-in. hose. Tests show that rivet-heating is done at the rate of three $\frac{3}{4}$ by $2\frac{1}{2}$-in. rivets per minute, using 244 cu. ft. of gas per hour.

The Selas system is used for mixing the gas. The method of operation is as follows:

The machine is operated

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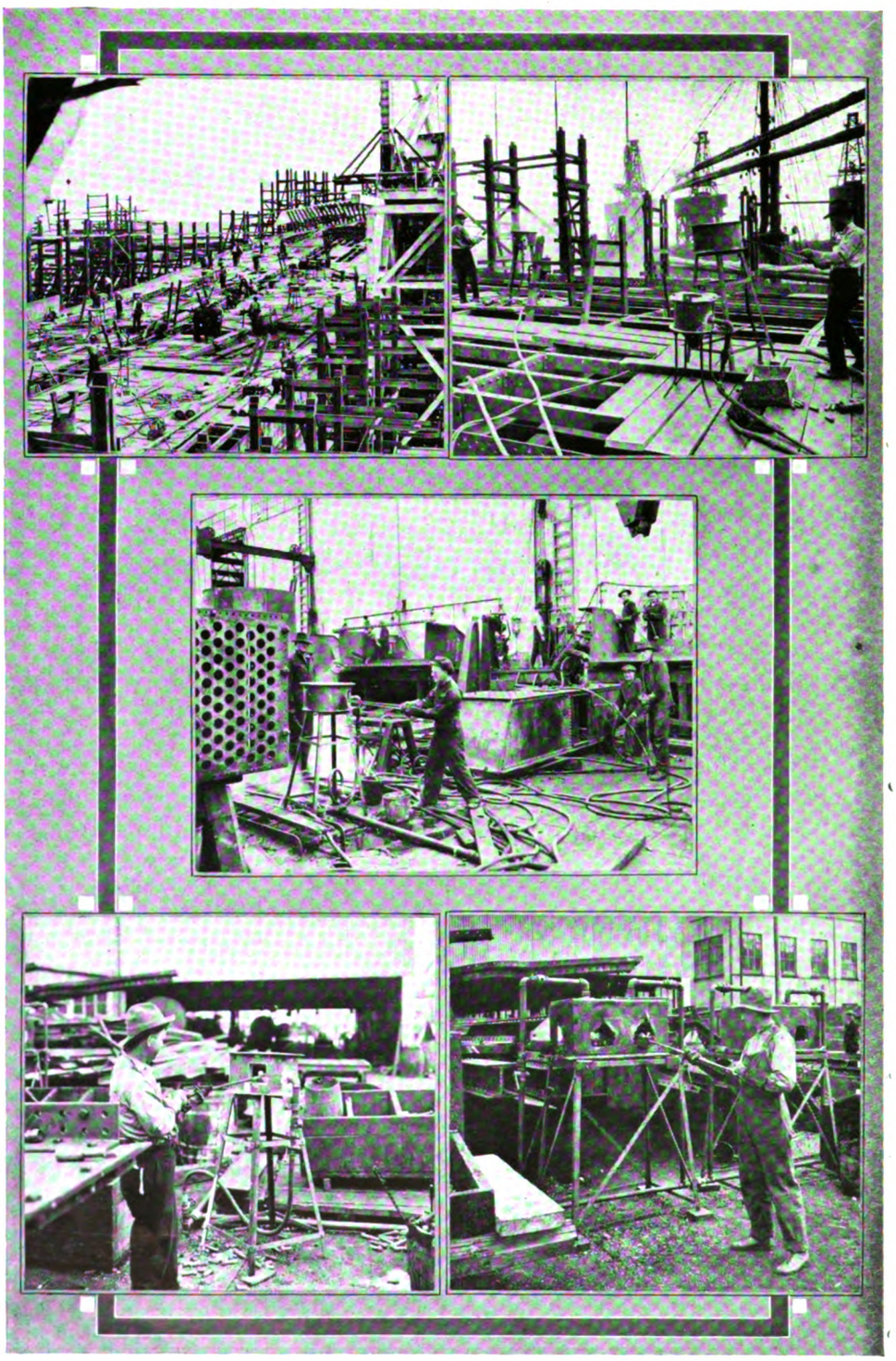
by a 10-hp. motor. Air is admitted on one side and gas on the other. The gas is then reduced to atmospheric pressure, or air pressure, so that the two are balanced; then both are drawn into a mixing chamber in the proportion of one part gas to one and one-half air. This mixture is then compressed to four pounds per square inch and sent through pipes to the appliance. In the appliance the mixture passes through the Bunsen air-mixer, where additional air enters for the complete combustion or burning of the gas. The partial mixing, or pre-mixing, of gas with air by the Selas system prepares the gas to be saturated readily with air when it reaches the Bunsen mixer. This is on the theory that where gas passes through the ordinary Bunsen mixer it is only streaked on the surface, or stratified, with air. This result is similar to what happens when a dry sponge passes through water; the surface only will get wet; whereas, if the sponge is moist it will be saturated quickly. So, if gas is 'dry' of air it picks up air only near the surface, whereas if the gas is mixed or 'moist' with air it readily saturates with air in passing the Bunsen, or air opening. The Selas-Bunsen mixer is specially made so as to prevent any backfire in the burner. It prepares the gas for complete combustion and thereby produces a high flame-temperature.



GAS AT THE MOORE YARD

Above are two views showing single-burner forges in use on hull construction. The centre shows single-burner forge in the boiler-shop. At the lower left is another single-burner forge and at the lower right is a double-burner forge.

The Selas gas-mixing machines are placed in a central part of the plant and the distribution pipes are run thence to the different docks and shops. The pipes are run up the sides of the ships and thence connections are made by rubber hose to supply rivet-heaters. These heaters are generally on the deck of the vessel from which the assembling is done.

The big gas-furnaces are located in the shops. These furnaces are 40 ft. long and 4 ft. wide, with openings on each end to iron platforms on which the hot steel shapes are bent. These platforms are full of square holes like a checkerboard. Upright pegs, or clamps, are put in these holes, making the form or pattern around which the hot steel is bent into shape. The gas is supplied by the Selas system as previously described. The furnace requires about four and a half hours to reach working temperature, which is

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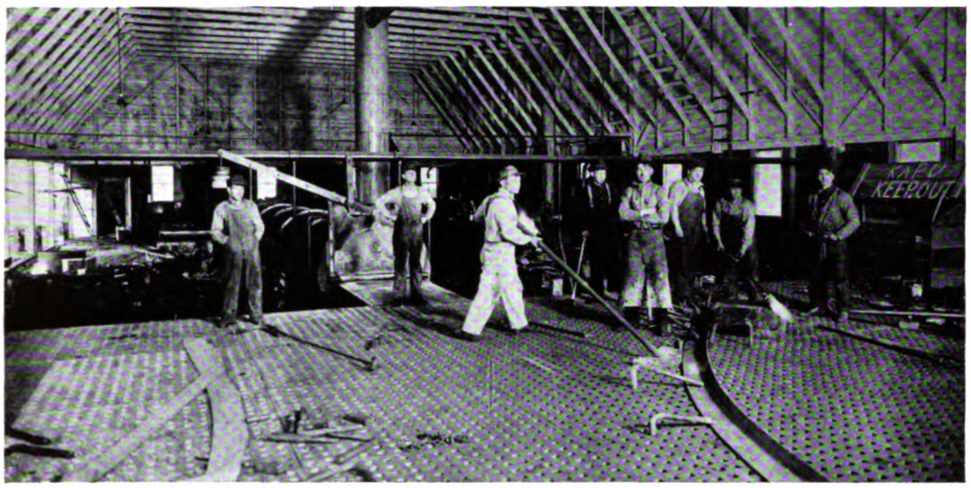
between 1850° and 2000°F. Channels 8 in. wide and 40 ft. long are heated uniformly in about twenty minutes and are bent and hammered into shape with one heat. The gas consumption averages 6000 ft. per hour. Smaller shapes are handled in less time and with less gas. This type of furnace is of high efficiency because of temperature control, low cost of maintenance, and absence of smoke, oil fumes, and dangerous flames. Small furnaces are used for heating small plates and for casehardening of special parts.



GAS-FURNACE FOR HEATING SHAPES AT THE HANLON YARD

The advantages of gas in rivet-heating as compared with coke or oil are summarized by Letson Balliet, of the engineering staff of the Moore Shipbuilding Co., as follows:

HEATING COPPER EXPANSION JOINTS AT THE MOORE YARD

The bull-riveters put in 300 to 500 more rivets per day.

Oil-heated rivets ruin two to three dies per day; this is not so with gas.

Rivets are not burnt or lost; no time is lost cleaning forges.

Rivets are softer; there is no scale, no hammering to get them into holes; they drive better; are better when finished; use less air in driving and put less wear and strain on bull or gun.

No compressed air is required for forges, saving $1 per day per forge, besides saving on hose.

No deck-crews are needed for cleaning up spilt oil and coke, handling oil and coke, similar work, a saving of $500 per day.

A ton of burnt rivets is saved per day. Time is saved burning out bad rivets and re-riveting.

Working conditions promote speed by eliminating excessive heat, smoke, and dust in holds of vessels.

It is estimated that 6,000,000 cu. ft. of gas is used during the construction of a 9400-ton steel vessel, for rivet-heating, bending shapes, casehardening, and miscellaeous work of all kinds. This equals the monthly consumption of many cities.

Large Machine-Shop in Mexico

According to G. B. Stewart, U. S. Consul at Chihuahua, work will soon be completed on the new modern machine-shop being constructed by the American Smelting & Refining Co. at its lead-smelter near the city of Chihuahua. The building is to cost 150,000 pesos, and the new machinery, which is to be purchased in the United States, at least 50,000 pesos additional. When the shop is in operation it will be possible for the company to handle large and difficult jobs, which in the past could not have been undertaken.

First Egyptian—"I see they finished the Great Pyramid last week. What do you think of it?"

Second Ditto—"Somebody got a big graft. You take it from me, fifty years from now the whole thing will have crumbled."—'The Earth Mover.'

THE oldest inhabitant says he knew of a union once that had never called a strike.

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The Relation of Health to Work*

By Thomas Darlington

We have come a long way in the last 40 years. I go back to when I commenced the practice of medicine, and I am in my 40th year of practice. The annual death-rate in this city when I had an office down in West 30th St. was 35 per thousand, nearly 36. Now, it is only a little over 13, because of discoveries in medicine, just as wonderful in medicine and prevention of disease as all the other discoveries that have come along in the last 50 years—the great wonders in electricity, means of locomotion, everything that we have today. Likewise medicine has opened a new field, particularly in prevention of disease. We have commenced to consider man in a different light. We know and have known for a long time that it pays to take care of an accident. Compensation laws have been enacted and we know that it costs something every time a man loses his finger. It used to be, even 10 years ago, that in some of the steel plants when men became injured the wound would become septic in fully 50% of the cases, 500 out of a thousand. Today in various steel plants, such as the U. S. Steel Corporation, Carnegie, Youngstown Sheet & Tube, only one in a thousand becomes septic, and in the Bethlehem Steel very much less than that. In the big plant at South Bethlehem in four years of accidents, taking every little thing into consideration, every little scratch, 50 or 60 cases a day, there have been only two cases of septicæmia.

Now we have come to another time when we find it pays to take care of the human machine to even a greater degree and in other ways. The deaths in the army both from disease and those killed in battle are nothing compared to those who become ill and die in industry. Man is a machine. How is he usually cared for? Let me give you an illustration. Here is a man who has made his pile. He goes home and says, "Wife, we have made a million. I have sold out the plant, we are never going to work any more, you and I, we are going to get a Rolls-Royce and we are going to motor out to California. We are going to run the motor slowly across the country and will see everything, and we are going to take our ease the rest of our life; but you know, of course, we will come to places where we will find it very difficult to get water and in other places we may not always get oil, especially when we cross the desert, so I'll tell you what we will do. We will take the machine out next week and take it out two weeks without water and we will take it out two weeks without any oil and we will make it hard as nails." Rot, isn't it? That is something like the care that a soldier in the army is supposed to be given. I have just come out of the army and I know something about it, having the contagious diseases of fifty thousand men to look after, and it is the same care that is often given to men in industry. We treat them just like that man treated his machine. We think that hardship hardens a man and we look at the brown faces of the men that have come from abroad and say they are "hard as nails," but I am thinking of all those that went down, of many deaths, for which there seemed to me to be no necessity. Given a well man and you have absolute control of him. Why should he get ill?

From my standpoint, efficiency depends primarily on health. The German philosopher, Münsterberg, said it depends on a man's psychology, but what does psychology depend upon? Flow of blood to the brain, and flow of blood to the brain varies with all kinds of things, with the weather, the pressure of the barometer. Suppose your liver is out of order. Don't things seem to have a green and yellow hue? If you don't think psychology changes, let a man try six of these [indicating a cocktail] and see whether his psychology changes. Instead of feeling poor, you own the world. Psychology depends on health. Efficiency depends on health, and it pays to take care of a workman.

As a matter of fact, illness in industry already has an effect on operating cost that is far from being realized. Whenever a man is absent from his work because of illness, it is usually necessary to have someone else take his place. The substitute, as a rule, is a less efficient worker; he makes a smaller output for the day's wages, he spoils more raw material, he requires more supervision from the foreman, who is thus distracted from more important work, while procuring and sending the substitute to the work needed involves a cost and usually a delay in the operations. I have seen a business fail because it depended on one man, the superintendent, and he got typhoid fever and there wasn't anybody to run the business.

Efficiency depends on health, and health depends on three things: the care that a man gives himself, the care that industry gives him, and the making and enforcing of health laws, city, state, and national. What can people do for themselves? Before I take up that question, I have been told that some of the members here are interested particularly in the question of fatigue. I happen to be chairman of the Committee of Fatigue of the Council of National Defense and I want to talk to you about how people get tired. Fatigue means much to a worker. If a person catches cold it is when he's tired;

*Abstracted from an address delivered before the Mining and Metallurgical Society of America. For many years Dr. Darlington was Commissioner of Health in New York.

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if you catch an infectious disease it is when you're tired. Fatigue lessens resistance to disease. Fatigue is the one great thing in this world that we want to avoid. What makes people tired? Work? No. Very seldom. It isn't work. Cold will make you tired. It makes every cell in the body work fast. A great many things make fatigue, but seldom work. That is a different idea from that which most workmen have.

I once ran for a political office in this town—I was defeated—Borough President. While I was campaigning at that time, standing on a soap-box, I heard a man say, "My friends, the time is coming"—this was down on the East Side—"the time is coming when we are going to have a three-hour day." Think of it, a three-hour day, because they believe, like all the Bolsheviki, that work is the curse of the earth. That isn't true. How do people get tired? Now, to know that you have got to understand a little physiology. We must understand the body. Every part of the body is in motion all the time. When any part isn't in motion in the body it is dead. You are manufacturing heat, you are getting energy all the time. That comes from your food. Food goes into the body, is taken up and stored in the body, and you have it to use. It is then burned up by means of the oxygen which you breathe. All the time in the body there is a breaking-down process, all the time there is a building-up process.

I move my arm like this [illustrating by bringing the forearm up]. What has happened? The will sent an impulse into this muscle, the biceps, that is attached to the arm. It contracts. As the muscle contracts up goes the arm, but I have used up some energy in this muscle. Energy comes from something. What is it? Something in the muscle—$C_6H_{12}O_6$. What is that? Dextrose. The $C_6H_{12}O_6$ becomes $2(C_3H_6O_3)$. What is that? Lactic acid. If I keep on doing that pretty soon that muscle gets sour—tired. What becomes of the lactic acid? Burns with the oxygen, finally comes out CO_2 and H_2O, and goes out through the lungs and the kidneys. Very simple, isn't it?

First we use up all the sugar. All the starches go into sugar. We store that in the liver. That is the coal-bin. Then when you have used up all the sugar, you use up the fat. That is much more complicated. After you use the fat in the muscle you use the muscle itself. How do people get tired? We will suppose they have no sugar in the muscle. Well, then, you haven't anything to work with, have you? Then you are tired. It is a great deal like the energy developed in a boiler. You have got to have the coal. What a difference whether you get slaty coal or whether you get Pocahontas. A wonderful difference, isn't there! The next thing necessary is a draft. If there is no draft it doesn't burn well. And the next thing is to get rid of the ashes of waste.

Energy depends first upon the food you eat, the kind of food, whether the system can use it or not, whether you digest it and store it away. Next upon the oxygen which is carried by the red blood-corpuscles, the hæmoglobin in the blood. The first thing then in the question of fatigue depends upon the character of the food that people eat. Very few people understand that, and so far as the workmen are concerned few of them or their wives know anything about feeding the man, and any old thing goes in the lunch bucket. One day I opened 250 lunch-boxes in a Carnegie steel plant. The first bucket opened contained a whole boiled cabbage. How much $C_6H_{12}O_6$ did he get to use in the muscle, how much energy could he develop from that cabbage? It was good for one thing. Perhaps I will tell you a little about that later. The next man had nothing but cake and honey. He got all the $C_6H_{12}O_6$, but what did he get to make up for the loss of protein and muscle? Nothing, and he was thin.

But it is not alone a question of the kind of food that he gets. Does the man digest that food? Was it mingled with bacteria in the mouth and fermented in the stomach? Did the sugar split up into acids in the stomach before it got into the muscle? Don't you see that energy is the converse of fatigue and fatigue the converse of energy? Energy depends first upon food and its digestion, its absorption and utilization, and next how are you going to burn it? It is burned with the oxygen. Take a drop of blood from a man and examine it under the microscope and we find that he has a 5,000,000 blood count. Yes, that is a good healthy man. It is up to normal. The next man we take we find he has 2,500,000 blood count. Doesn't it take twice as rapid a circulation of the 2,500,000 to carry the hæmoglobin as the man with the 5,000,000? Yes, twice as fast the blood has to work because he has anæmia. What does anæmia come from? Dark unventilated rooms, infectious disease, poor food, lack of movement from the bowels, bacteria in the mouth, in the tonsils.

Next get rid of the ashes of waste, and how do we do it? The waste is all through the body.

There was an old professor in Turin who watched quails migrating across the Mediterranean; some of these he caught that were very tired after they flew across the ocean and he picked them up. They were too tired to prevent his picking them up. He took them home. Next year he caught some more and he took the tired quails and took the blood out of them and put some of this blood into the quails that weren't tired that he caught the year before and it made them tired.

How do you get rid of this waste? Well, the blood takes it up and takes it away. If a person drinks a great deal of water that helps. If you have a shower-bath you drive the blood inside and then it returns to the surface again and that helps and soon you get rid of all fatigue and the waste goes out through the kidneys. But other waste produces fatigue. Sometimes a person does not have a regular movement from the bowels, because instead of having modern water-closets you find places that you couldn't dignify as even privies—simply an old bar. One man made them as bad as he could. Why? He didn't want the men to linger there. Well, he lost lots of money, and I will show you how. In fermentation we have bacteria in the bowels all the time. In fermentation, particularly of protein food, you develop certain poisons. These poisons are known as indol, skatol, mercaptan, and

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certain phenols. The last develop particularly from eggs and milk. The most common poison found is indol. That is absorbed and becomes a sulphate in the system and that is known as indican. When you have a urine examination you see so much sugar, so much albumen, and so much indican. The sulphate of indol is indican.

To show you how it works and how a lack of movement of the bowels produces fatigue, a man gets up in the morning and he hurries, he hasn't quite time to have a movement at that moment. He goes to work, doesn't go outside, he has got a lot to do, and the little amount of liquid material around the movement in the lower part of the bowels is absorbed and the desire to have a movement passes off. What has happened? Let's see for a minute. [Draws sketch on blackboard.] This is a stand. This is a cylinder which is smoked. Here is a short arm fixed. Here is a long arm on a pivot. We put in here a muscle, the back of a frog's leg, called the gastrocnemius muscle. We now put an interrupted current in here and the smoked cylinder is timed to revolve as you put an interrupted current through. The muscle contracts. That pulls up this arm so that on the cylinder you get a record. We take a muscle and into this muscle we put a few drops of salt and water with a hypodermic syringe and take the record. Now, if we can get two muscles from the back of a frog's leg, get them out just exactly the same, and we want to see the difference in the muscles we take the first one with an injection of a little salt and water and this is the record that we get of that muscle [illustrates on blackboard], taking about every fifth mark and finally the muscle stops contracting; it won't go any longer; it is all used up; it is dead. Now, we will take a little indol from a movement, a fraction of a drop, and this time put that in with the salt and water and inject that into the other muscle. What do we get? The muscle stops work in a little more than one-third of the time. That is the man's lifting capacity. The man who hasn't had a movement of his bowels in the morning, absorbs that material through his system. The man has only about a little more than one-third the efficiency of the other man so far as his actual muscular capacity is concerned. If the one man is worth $6 a day, this man is worth $2.30. That is putting a movement of the bowels into dollars and cents.

Don't you see that fatigue doesn't depend entirely upon the amount of work that a man does? It depends, first, upon the energy he receives from his food and, second, upon the quality of blood that is carrying the oxygen to the tissues. So much so that when he gets up in the morning he puts up his hands to Heaven and says, "Thank God, there is another day to work." He works well because he has the energy, and he loves it.

Once when I explained this to some of the steel people, I said that if I was building a steel-mill or any other kind of a mill the first thing I would do would be to build a marble water-closet so as to get everybody to go in. So one of the steel-men did that and all the Italians went in there and ate their lunch. You see, there are some other points which you must consider besides the mere health of the men. Once in a while there comes a slip.

About the efficiency of the man himself, don't you see it goes into every phase of that man's life?

Before the War we were just approaching these things. Back in the Old Testament it tells about the Jews when Nebuchadnezzar was outside the walls and had his great army there and his banners and they all gave up everything they were doing that they didn't think was just right. And some said "What about these slaves of ours?" and they freed them all. But one day they saw the banners of Nebuchadnezzar in the early morning disappearing in the far distance and when the danger was past they said, "Where are those slaves of ours?" and again they made them slaves.

While the War was on it was our winter and the leaves were off the trees and we could see a long distance. We must continue to see that long distance. We can't go back to our ante-bellum days. We have got to go forward. We have had a vision of what is right and we can no longer go back, but must do everything that we can for those who are ignorant and less favored by birth in station of life.

Let us now take up one or two other things. I said that a man's efficiency depends upon what he can do for himself. Now, among the many things of personal hygiene besides the question of taking baths, care of the eye, the ear, and the nose, and everything else of that kind, and regulation of a man's meals, there are simple things like the brushing of teeth. How many workmen in the factory brush their teeth every day? To be efficient men they must brush their teeth seven times a day. Do you suppose any of your workmen know that? Not one of them. Why must they do it? Let's just look at it. It is a simple thing. The manufacturer is interested in it because of his output. If I had a factory I'd make every man a present of a tooth-brush. It was done in the army. I helped to take care of 50,000 men and had to talk to them. Pneumonia killed some of them because they didn't brush their teeth. What did they do with the tooth-brush? Used it around the edge of the shoes to get the mud out. What is the first thing about the teeth? Well, we need them for enunciation. In the army it was absolutely necessary that orders should be distinct. The chewing of food means a lot in energy. Still, that means little compared with some of the other things. Personal appearance is one. We all like beauty. You cannot imagine a beautiful woman without any teeth. But let that go. In the mouth are 48 varieties of bacteria. If you chew the food without brushing the teeth you swallow those bacteria and the food ferments in the stomach and often it passes the quarantine of the stomach and goes down to the bowels.

There was an old doctor in 1822 who lived on the shores of Lake Champlain—Dr. Beaumont. He had a patient that was brought to him by the name of Alexis St. Martin, who had a hole shot in his stomach, and the doctor used to put food in this patient's stomach and watch it digest. He found that gastric juice would keep indefinitely under ordinary circumstances but that if he swal-

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lowed much saliva it spoiled quickly. Why? Because the saliva was full of bacteria. Do you know that in the army in the grippe epidemic very few if any died from grippe? They all died from pneumonia. Why? There are four types of pneumonia germs. Nearly all died of the fourth type. That is a mouth bacteria. They got the grippe and then the pneumonia bacteria that inhabited their mouth and grew there went into the lungs and killed them. If they had all brushed their teeth regularly, many of them would have lived. Many, very many of the 600,000 people that died in the United States would be alive today if they had brushed their teeth in that epidemic. But that is very little compared with the other thing. A tooth dies, but you do not always know it. At the root of that tooth there comes a small abscess. From this bacteria and the toxin are absorbed in the system. Just the same as in the tonsils. The tonsils and the teeth make over 90% of our infectious diseases. The poison may go into the heart, producing vegetation of the valve; or go into the kidneys, and make Bright's disease; or go to the bladder and make inflammation of the gall-bladder. Nearly all rheumatism comes from bad teeth.

Do your workmen know that anæmia, the loss of the red blood-corpuscles that carry the oxygen to the tissues, is often due to abscesses at the roots of the teeth or old roots in the mouth? Have you got a dentist in every factory pulling out these old roots? No. The first thing I did at Hog Island, where I was consulting surgeon, was to put three dentists there. They said a great deal of money was spent there. Thank God, I had an opportunity to demonstrate some things that had never been done before.

Deaths from shock and hemorrhage! Men die in a few minutes from shock, but if you have blood to inject into them right away you often may save them. We hired three men, and gave them $1200 a year apiece and fattened them up and kept them raking leaves, and when a man got injured we took some blood from them and injected it into the injured person. We saved three men worth $5000 each according to the Pennsylvania Compensation Law the first month. $15,000 against $3600 in the first month!

How about washing of hands? It is from dirty hands that bacteria get into the mouth. What does the surgeon do? Simply wash his hands? No, he puts on rubber gloves, even after he has put his hands into absolute alcohol with bi-chloride. I remember when I was a boy going to college George Francis Train sat in the park. It was back in 1874 and I remember asking old Train, "Why won't you shake hands with anybody?" and he said, "I don't know where a man's hand has been last." There is something in it. Take the case of 'Typhoid Mary'. How did she give typhoid to 28 different families? Because she had typhoid germs on her hands. Very little, but it gave disease. Does every workman wash his hands before he eats lunch? There is something else that workmen generally do not know. That man that was talking about the three-hour day, did he know that Scripture says, "By the sweat of thy brow thou shalt earn thy bread?" The man that doesn't do it doesn't live as long as the worker. To live long you have got to work. Work leads to longevity. The rich man of today, what does he do? Does he do like the man in the Bible who said, "Now, soul, we will enjoy ourselves and eat, drink, and be merry?" The rich man today builds an 18-hole golf-course and works like the devil to keep his health. Work doesn't hurt anybody.

That is what we have got to teach the workman.

We have in the neck a gland called the thyroid. We have more important ones over the top of the kidneys, little thin glands called the adrenals. These are like the governor on an engine. They control our circulation. If you lose those glands you die. These adrenals throw out a powerful drug. I know of two men at the front where a big shell burst and adrenalin was thrown out so that every hair stood on end for a week. A grouch, grief, anger, or worry are ruinous to the body. They cause adrenalin to be thrown out. But joy, love, laughter prolongs life. What does that mean? It means that we must teach the employee cheerfulness; that every man shall find in his daily work his greatest happiness. Just as God Almighty found happiness in the creation of the earth, we, made in His image, must find our happiness in our daily work, no matter what that work is.

I have simply given you an illustration of the care of the human machine. I have put before you the money side of the question. We have to do that with a corporation. In all the big plants of the steel industry throughout the United States many million dollars have been spent along these lines, in education of workmen, teaching them to wash their hands, to take showers, to do all these different things, and providing facilities for them and their families. Wonderful work! The steel industry today leads the world as a great industry. I am not saying that to the disparagement of others as far as welfare work is concerned, but it is the largest industry.

We now come to another side of it, and that is this: Cain's answer by the Garden of Eden was, "Am I my brother's keeper?". The Bolshevists and the Socialists have used that for a great while, this cry of the brotherhood of man, which means nothing to that class. When I was in the Department of Health we had 187 laws. They all meant one law. How can you translate them into one law? The man that loves his neighbor won't spit on the sidewalk, he won't sell his neighbor bad food, he won't let smoke come out of his chimneys, he won't let his child with contagious disease run around and spread the disease. That is the thing that we must teach workmen, the love of their neighbors. It is a great thing to relieve suffering. It is a far greater thing to relieve penury and crime, so we can say with Abou ben Adhem, "Write me as one who loves his fellow men."

"HAVE you ever taken a tail-spin in an aeroplane?

"No, but I've been called upon unexpectedly to make a speech, and I guess the sensation is about the same."

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Gears

By EDWARD LESLIE

"To most mechanics a gear is a gear,
'A yellow primrose by the shore,
A yellow primrose was to him,
And it was nothing more;'

"And, in fact, a gear is often a gear and nothing more; sometimes barely that.

"But if the mechanic will look beyond the tips of his fingers, he will find that it can be something more; that it is one of the most interesting objects in the field of scientific research, and not the simplest one. That it has received the attention of many celebrated mathematicians and engineers; and that the study of its features will not only add to his practical knowledge, but also to his entertainment. There is an element in mathematics and in its near relative, theoretical mechanics, that possesses an educating and disciplining value beyond any capacity for earning present money. The thinking inquisitive student of the day is the successful engineer or manufacturer of the future."—Grants 'Gearing'.

Gear-wheels are such common objects today in any manufacturing concern, and are made in such numbers, and so easily, by the aid of patterns and gear-cutting machines, that one hardly stops to consider what they really are, why different types must be constructed upon different curves, and what mathematical calculations are required in the design. Then there is the theoretical side, which is so seldom explained in a simple manner, that the average person has neither the time nor the opportunity to look into so interesting a field of study.

The method pursued here will be to discuss the subject in as simple and direct a manner as possible. "The simplest diagram is often a better teacher than a page of description." To discuss without controversies the many sides of gearing with its special forms and modifications will be the aim of this series of articles, and perhaps it will lead into a study of interest to the general followers. It will be a practical treatise for those who make patterns, and a theoretical one for machinists who have the machinery to form the teeth from the blank, without the layout necessary, and tooth shaping that falls the exacting task of the patternmaker.

Part I

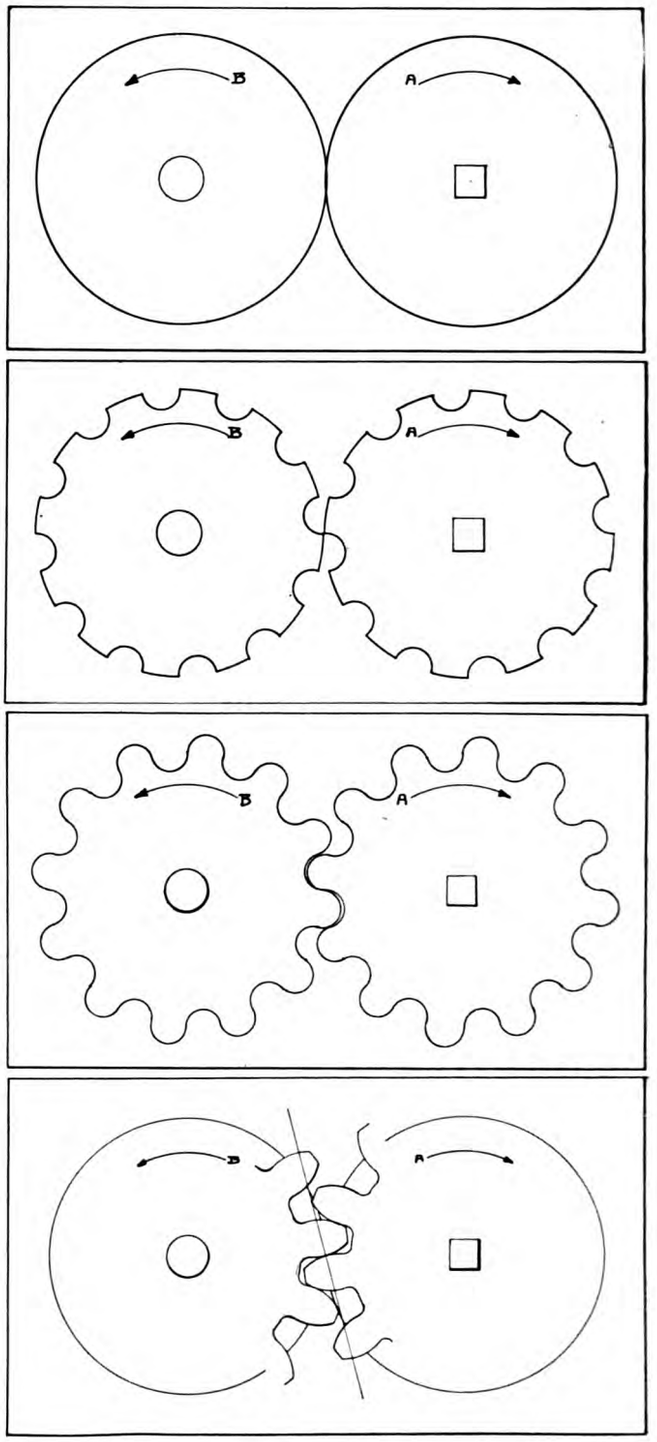
Friction-Wheels: Take two wheels, or cylinders, as in Fig. 1, with their surface in close frictional contact, and for example, the same size. When wheel *A* turns one complete revolution, wheel *B* should also turn one complete revolution, providing there is no slippage.

For the many cases of motion where slippage cannot be permitted, the friction-wheel is not suitable. To overcome this, it is necessary to place small projections on the wheel surfaces. These projections must be designed so that the motion transmitted from one cylinder, or wheel, to another, is uniform and even, as in the case of the friction-wheels.

In the surfaces of the wheels *A* and *B*, cut grooves as in Fig. 2; the spaces between grooves are called lands. Upon the lands add parts, as in Fig. 3. These parts are called addenda; a land with its addenda is called a tooth. A toothed wheel is called a gear.

The circumference of the wheels without grooves or addenda is called the pitch-circle. This circle exists in every gear. The problem in gearing is to shape the teeth so that the pitch-circles will touch each other without slipping.

Fig. 4 shows how such a result is obtained, throwing the friction-wheels with teeth formed on them part way. The line intersecting the pitch-point, or where the wheels touch, is the $14\frac{1}{2}°$ pressure angle, which will be discussed in a later chapter.



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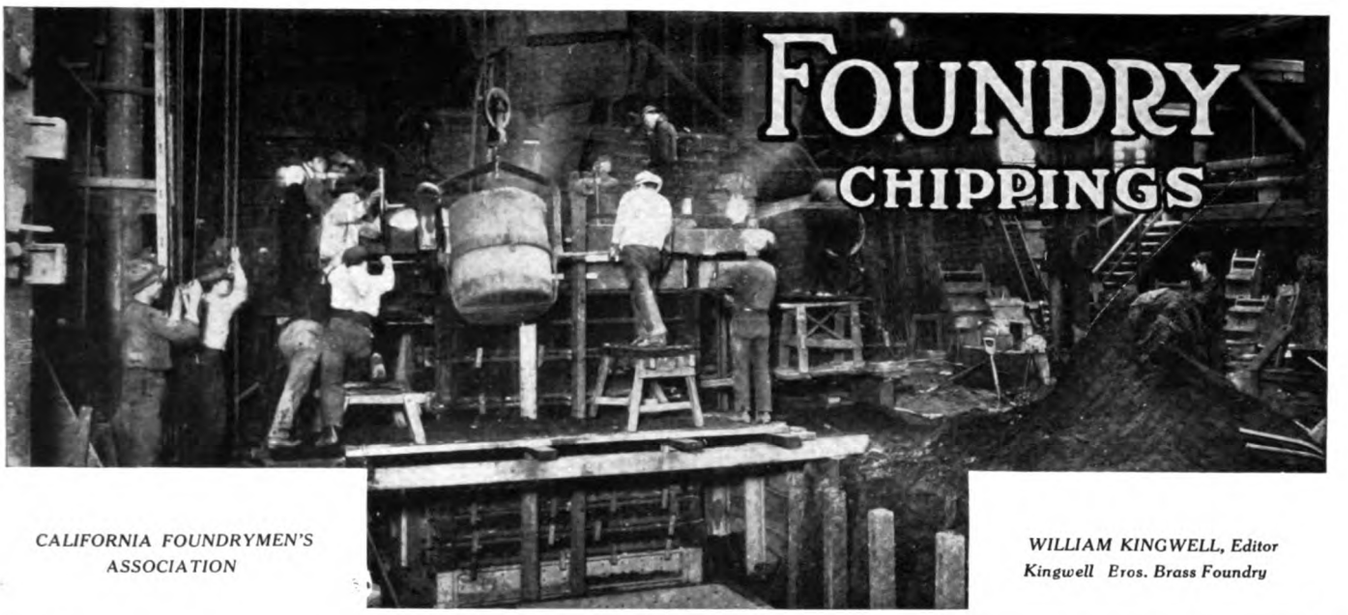

CALIFORNIA FOUNDRYMEN'S ASSOCIATION

WILLIAM KINGWELL, Editor
Kingwell Bros. Brass Foundry

Manufacture of Cylinders for 'Caterpillar' Tractors

The purchaser of a tractor demands high quality and a moderate price, two things that seldom go together in these days of high costs of labor and material. Only by taking advantage of labor-saving devices and by the employment of methods minimizing the amount of spoiled work is it possible to attain this result. This is well illustrated by the manufacture of engine-cylinders by The Holt Manufacturing Co. at Stockton, California.

The mixture used for the cylinders is as follows:

	%
Silicon	2.00 to 2.20
Manganese	0.50 to 0.70
Phosphorus	0.35 to 0.60

The aim is to have the content for the above three elements half-way between the upper and lower limits. The maximum allowed for the sulphur is 0.13%. The cupola charge is composed of 10% steel scrap, and about 30% pig-iron and 60% cast-iron scrap. The exact proportion between the pig and the cast scrap is determined by the sulphur content.

The cylinders are cast horizontal. The molds are

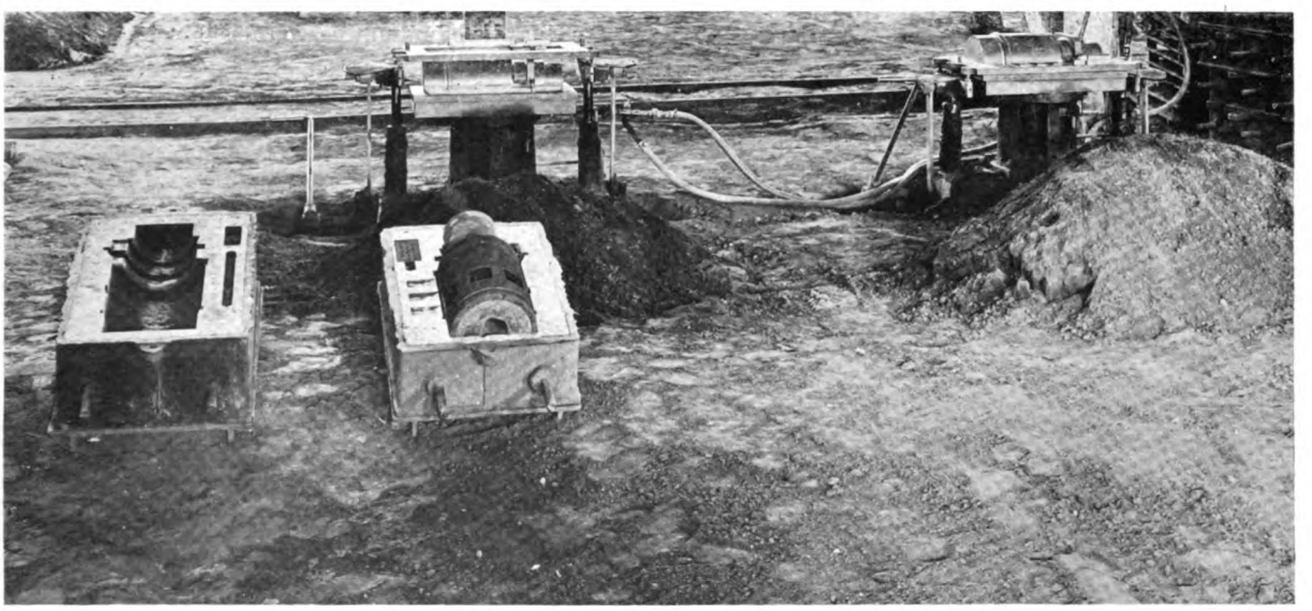

FIG. 1. CYLINDER MOLDS WITH MAIN BARREL CORE, ALSO SKIMMER CORE IN PLACE IN THE DRAG. IN THE REAR ARE THE MOLDING-MACHINES ON WHICH THE WORK IS DONE

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made on an International jolt-stripper, as shown in Fig. 1. Two men can make 100 molds per day, whereas the best record for hand molding was 30 molds. Fig. 1 also shows the molds with a barrel-core set in the drag. These cores are made at the rate of 200 per day by one man on a Henderson jolt machine, manufactured by the H. C. Macauley Foundry Co., of Berkeley.

The sand used for the molds is obtained near Ben Ali, about six miles north of Sacramento, and is handled by Cannon & Phillips, and by T. M. Burns, both of Sacramento. The deposit has been worked for some time to furnish brick-clay, but it was not until comparatively recently that it was discovered that overlying the brick-clay was a deposit of excellent foundry-sand, remarkably uniform in chemical composition and in fineness. A typical analysis is as follows:

	%
Silica	71.08
Iron oxide	3.71
Alumina	14.01
Lime	3.98
Magnesia	2.43
Alkalies	1.71
Loss on ignition	3.02

This sand is used almost exclusively in the foundry

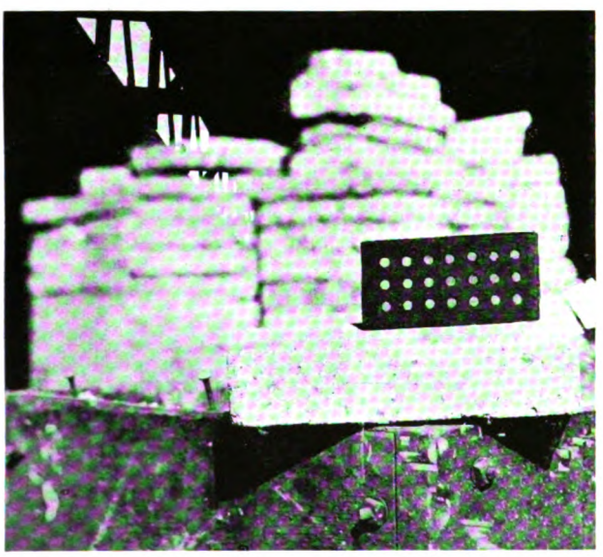

FIG. 2. SKIMMER CORE

for ordinary molding, except where a specially fine surface is desired, when it is mixed with a little Decoto sand. Curiously enough, not long ago, representatives of a Sacramento foundry called at the plant to inquire where the sand was obtained that they had heard was giving such satisfactory results. Their surprise when they learned that the sand came from their own vicinity can well be imagined.

For the barrel-cores, a mixture composed as follows is used:

112 parts 'Lapis gravel.'
112 parts Decoto sand.
96 parts Antioch sand.
4 parts goulac.
4 parts Baker oil.

A factor of importance in obtaining clean metal in the cylinder, free from slag and impurities, is the use of the 'skimmer-core.' As will be seen in Fig. 1, there is a recess in the upper left-hand corner of the drag, and the corresponding upper right-hand corner of the cope. In the recess in the drag, the 'skimmer-core' shown in Fig. 2 is placed. The gating is arranged so that the metal passes down through the skimmer-core into the drag and up into the recess of the cope and thence into the cylinder proper. The result of this method is that the worst impurities are caught on the skimmer-core and the remainder stay in the recess provided for them in the cope, leaving good clean iron for the cylinder itself. Such success has been attained by this method that when it was first adopted, the men in the machine-shop were convinced that a change had been made in the composition of the mixture used. The material was so uniform and could be handled with so much greater ease in the lathe than formerly, that they were certain that a different kind of iron was being used. In fact, the resultant saving in machine-shop costs has been even more important than the practical elimination of spoiled castings.

He was walking post that night for the very first time.

Corporal of the Guard: Have you seen the officer of the day?

Rookie: Nope.

Corporal of the Guard, an hour later: Have you seen the officer of the day yet?

Rookie: Nope, not yet.

Ten minutes later: Halt! Who goes there?

Voice: Officer of the day.

Rookie: Oh, you're going to catch hell. The Corporal of the Guard's been hunting you for an hour.—American Legion Weekly.'

First Negro: Well, how's you all?

Second Negro: Jest 'bout right, how's you all?

First Negro: Oh, I'se all right, but I lost my wife last week.

Second Negro: How cum, you done lost yo' wife?

First Negro: Well, you see her husban' done cum and took her home.—'The Yellow Strand.'

A naval aviation cadet at Miami was assigned to a sea-plane with orders to stay in the air for an hour. After a flight of thirty minutes, the cadet landed.

The division commander, with fire in his eye, descended upon the luckless student. "What's the matter with you?" he demanded. "I told you to stay out an hour. You've only been gone half that time."

"Really, sir," replied the student, "the air is awful rough. I never saw anything like it! Why, I looked up the road toward Miami, and it was full of blackbirds walking into town!"—'Everybody's Magazine.'

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The Strike

By EDWARD J. FOWLER

Any attempt to analyze properly the labor difficulties at this time would fill a book, and each trade would have a separate analysis as befitting their individual case; but there are probably a few underlying principles, which we can readily grasp, and which are well worth considering.

This Bay District strike is in no sense a struggle between Capital and Labor, because Labor already had conditions and wages far in excess of any other district in the United States, with the possible exception of one shipbuilding district having little outlet for anything but ships; and in the face of these conditions and wages, and at a time when all lines were rapidly becoming more competitive, labor made a demand for still more.

Labor demanded more wages without offering any plan whereby these increased wages can be turned into productive value, making it possible to pay them.

Labor offered the plea that the H. C. L. problem made increased wages necessary, and then proceeded to decrease the weekly wage by cutting off a half day each week. This creates impossible conditions in the foundry trade at least, and makes it generally necessary to run only five days per week, with a loss in production of at least 15%.

Labor has created a condition in the foundry such that the national shortage of workmen cannot be filled from other than union sources, which, in effect, decreases individual production and therefore total shop production with consequent increased costs, and which will result in materially reduced orders.

Labor has frankly taken the stand that no man shall work in a foundry unless he is a union man. No American boy can learn the trade unless an opening occurs by virtue of a certain ratio of one to every five molders.

Labor is against modern methods of machine molding, as is evidenced by an output far behind Eastern shops operating the same apparatus with non-union help.

Labor assumes control of daily output of the workman to such an extent that the output is much below similar work elsewhere.

In general the situation existing previous to the strike was one that needed immediate correction if the industry would flourish. The trouble was not a matter of wages but rather of intolerable, drastic, un-American, and autocratic conditions imposed by subjugating the industry to the whims and caprices of the labor union, a condition under which the employer was supposed to go out into the kind world and collect an amount from the public that would enable him to pay for the wastes brought about by these artificial regulations.

There is no doubt but that the employer has reached the limit of his ability to compete and pay even the existing rates under decent and reasonable conditions, but any attempt to pay the existing rates under the conditions noted above was ruinous and impossible.

If the workingman must have these pre-strike rates to combat the H. C. L., why can't he come through with some production, and work for his money just as the employer has to do? Why must the employer see his shop in a continual turmoil because some workman is always wanting more pay for less work?

The public interest demands that some plan be formulated whereby Capital and Labor can get closer together with the result of some co-operative production; but just as long as the unions in general take the position that only their fraternity can do the work, no agreement can possibly be generally effective; and regardless of any formula that may be evolved, the foundryman, at least, knows that he cannot convert formulas into reasonable costs or orders, so that his problem resolves itself to a rather simple necessity.

He must have a full shop with ability to secure operatives without opposition as orders come in; he must have production at least comparable with competing centres; he must be relieved of petty opposition to the daily operation of his business; and, of course, must have co-operation and freedom from strikes. If he cannot conduct his business along these lines he had better keep shut down indefinitely.

No city the size of San Francisco can afford to have one of its important industries lie idle for any considerable period of time, and, in the past, some plan has always been devised to start the wheels with some patched-up agreement, which compromised the expressed points of issue, but which left the real issue (conditions of employment) to work out its own salvation. The time has, however, passed when the 'Aw, boys, get together' plan can be carried out, and we are facing the real problem, competition.

This strike affects every mechanic in every line, every clerk, every stenographer, every line of business in the city; the iron industry is liberally paid.

Collective bargaining in San Francisco is a miserable abject failure because Labor has not delivered the goods and there is no answer to the problem except the following:

A new deal that compels complete and co-operative understanding and work.

Book of a Thousand Excuses for All Persons Connected With the Foundry Trade

CHAPTER V

FOUNDRY-SUPPLY MEN'S EXCUSES FOR POOR MATERIAL

The foundry-supply man will tell you that he never delivered any poor material in his whole life. All material is good for some purpose. The thing is to know how and where to use it. The Nevercast Foundry ordered

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a barrel of No. 1 plumbago a few days ago. It was delivered by the High Speed Auto Co. Jack Punchem, the foreman of the foundry, knocked in the barrel-head with a clamp. Some of the plumbago spurted into his eye, and he was obliged to go to the emergency hospital for treatment. The doctor put some of the so-called plumbago under the microscope, and also made an analysis of the sample. Mind you, it was supposed to be Ceylon plumbago, 99% fine, but this is the analysis: black sand 65%, blue clay 15%, lampblack 6%, soapstone 7%, charcoal 5%, dirt 1¾%, plumbago ¼%. The foundry paid a premium of three cents per pound on account of its being such high-class stuff. When Mr. Foundryman complained about the material not being just right, Mr. Diamond Stud, proprietor of the Bonanza Supply Co., said, "There must be some mistake. I'll run out to the shop and have a look at the barrel." It was an easy matter to explain, as the High Speed Auto Co. had grabbed the barrel market 7X instead of 1X. If Jack Punchem hadn't hit the barrel so hard with that clamp, the chances for discovering the mistake would have been small indeed. No. 7X was not intended for the Never-cast Foundry, but should have gone to the Rough and Ready Foundry to be used on non-slip floor plates.

If you ring up for a barrel of core-oil (same as last) you are sure to get some new dope that is not fit to use. When you complain, you are told that your man does not know how to use it. If you order a ton of sea-coal and receive a ton of ground-coke screening, you are told, on complaint, that all coal is different from what it was before the War. Order some tinned chaplets and you get some rusty old boys rejuvenated with aluminum paint.

The foundry-supply man is never at a loss to fill your wants. You order a half-inch sieve, and he is all out of the half-inch size, but he will deliver two quarter-inch sieves in order to make it half. Order a ton of core-compound and if he only has half a ton on hand, he will deliver the half ton and charge you for a ton and a half. Order a barrel of molasses, if he only has half or quarter of a barrel on hand, he kindly makes up the balance with good spring water and charges for a full barrel. All foundrymen know that the supply man is a good-natured chap and a past-master in handing out 'bull'. It is a strange matter that regardless of how thin a man might be when he enters the foundry-supply game it is only a matter of a few months and he graduates from the slat family into the fat family. All foundry-supply men are fat and good-natured, and why should they not be good-natured? This strike business suits them because they are not obliged to send in any supplies, but just keep on sending bills. How they ever expect to collect them all is another matter. Anyway we would all like to be in the supply game and try it on the other fellow. It will not be necessary to have a number of excuses for the foundry-supply man, as it appears that this job is just one big excuse.

Our next chapter, 'Chemists' Excuses for Delay and Wrong Dope' will be a revelation, and we hope that we will all get some valuable free information out of this chapter.

C. J. P. H.

The Philo System in the Foundry

Once upon a time there was a system of raising chickens (Petaluma not Powell street) called the Philo System, and it was quite a fad for some years. First you make a coop big enough for four or five hens to crowd into, and fixed up with all sorts of do-dads and funny doodles, which are supposed to make them lay; then you pick out four or five good brainy hens without any teeth, and you make a noise like a grain of corn and coax them in.

Now the fun begins to commence; they have so much to do that of course they don't do anything; and if one hen in the bunch does not want to lay she will not let her sisters scab on the job either, and with the cost of eggs going up every day they only smile and gobble up the fodder as fast as you hand it to them.

You scratch around for greens and feed, and you mix up mashes and meat and clean up the coops always smiling and hoping they will reward you with an egg once in a while, but nary an egg.

Then your aunt visits you from the old home town and, after watching it, she says, "Why, Henery, you're doing all the work yourself, and if you let 'em rustle their own grub, you can't be any worse off", so you go out and bust about seventeen dollars worth of stuff, and let them run, and you get along better by collecting the eggs once a day, instead of jumping for a stop-watch every time you hear a cackle.

Isn't this just like the foundry game has been running for the last few years? The boss improved his shops and put in all sorts of new-fangled stuff so a man doesn't have to lift fifty pounds any more; and he hustled around looking up a class of work that is fitted to the shop. The men don't work Saturday afternoon, but you bet the boss does, and takes work home as well, but he doesn't get any eggs. His work-day gets shorter and his costs get longer. He finds the fellow in the next town with an old-fashioned coop plus old-fashioned ideas is beating him to it, and is getting eggs and lots of them. Then he tries to work up some special kinks so that he can call an egg by another name and get a higher price for it, but he can't get even this kind of eggs, so he finally says to himself, "These birds have got to do some old-fashioned work in the old-fashioned way and I'm dinged if I'll rustle their fodder for them any longer. I'm tired of adjusting troubles all the time, so I guess I'll rest around a bit under a spreading chestnut tree until they are willing to help keep the trough full".

CHEESE IT.

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Book Reviews

Governors and the Governing of Prime Movers. By W. Trinks. Pp. 229, ill., index. D. Van Nostrand Co., New York. For sale by 'Mining and Scientific Press,' San Francisco. Price, $3.50.

This is probably the first complete treatise on the subject in English. The chapters have the following titles: The direct-control governor as a motor; The centrifugal governor as a measuring instrument; Promptness and traversing time; Adjustment of equilibrium-speed; Shaft-governors; Natural period of vibration for governors; Effects of outside forces; Inter-action between governor and prime-mover; Discarded types of speed-governors; Rate-of-flow governors; Pressure governors; and Governor troubles. The book will be of value to those engaged in the design of prime-movers and also to those having oversight of their operation. An appendix contains a complete bibliography.

Steam Turbines. By J. A. Moyer. Pp. 488, ill., index. John Wiley & Sons, Inc., New York. For sale by 'Mining and Scientific Press,' San Francisco. Price, $4.

This useful treatise, originally issued in 1908, has been revised and enlarged for the fourth edition, taking full account of the recent advances in steam-turbine design. The general theory of steam-turbines is developed in several chapters on thermo-dynamics, nozzle and blade design, and the mechanical losses in turbines. The various commercial types of turbines in use at the present time are then discussed. Then follow several chapters on special types, including low-pressure and mixed-pressure turbines, extraction turbines, and marine turbines. Then come chapters, respectively, on steam-turbine economics, and on stresses in various parts of the turbine. Another chapter is devoted to gas-turbines. The book will be of value both to the designing engineer and the student.

Industrial Electro-Metallurgy. By Eric K. Rideal. Pp. 236, ill., index. D. Van Nostrand Co., New York. For sale by 'Mining and Scientific Press,' San Francisco. Price, $3.

This book is one of a series planned to give a complete review of industrial chemistry. The principal commercial processes discussed are electro-plating and other electro-deposition of metals, and the manufacture in the electric furnace of iron, steel, the ferro-alloys, and various other metals, as well as carborundum and similar substances, and the nitrates, cyanides, and cyanimides. The book is suited to anyone with a knowledge of elementary chemistry, and will be of value to those who are interested in the electro-chemical industries.

Practical Mathematics for Home Study. Pp. 488, ill., index. McGraw-Hill Book Co., Inc., New York. For sale by 'Mining and Scientific Press,' San Francisco. Price, $4.

The author of this book is associate professor of mathematics at the Armour Institute of Technology and has taught evening classes at that institution for a number of years. The book includes in one volume the material he has already published in four separate volumes together with some additional matter. It discusses thoroughly arithmetic, algebra through and including quadratic equations, plane and solid geometry, plane trigonometry, and the elements of graphical representation. Every effort is made to associate in the student's mind the practical application with the theoretical basis. For instance, worm-gearing and the use of the micrometer are discussed under common fractions, hydraulic presses under ratio and proportion, and the cutting of rafters under the geometry of triangles. While the main purpose of the book is to satisfy the needs of the artisan, the mechanic, or the self-taught engineer that feels the need of supplementing his early education in mathematics, it may also be found useful by many technically trained men that wish to review their mathematics, and who have lost or otherwise disposed of their college text-books, and who may be pleased to find under one cover all or nearly all they need.

Techno-Chemical Receipt Book. By William T. Brannt and William H. Wahl. Henry Carey Baird & Co., Inc., New York. For sale by 'Mining and Scientific Press,' San Francisco. Price, $2.50.

This is a remarkable book containing several thousand receipts of all kinds. These are arranged alphabetically beginning with alloys, artificial gems, and bitters, and going right through the alphabet to waterproofing compounds, wood-polishing, and yeasts. To many that are now suffering from drought, the division on bitters, cordials, and elixirs should alone be worth the price of the book. Joking aside, however, the scope is so wide and the ground is covered so completely, that there are few people in any occupation that would not find a great deal in the book of both interest and value. As is especially necessary in a book of this kind, both the table of contents and the index are remarkably full, making its use for reference easy.

Heat and Heat-Engines. By Andrew Jamieson. Revised by Ewart S. Andrews. Volume I. Pp. 543, ill., index. Charles Griffin & Co., Ltd., London. For sale by 'Mining and Scientific Press,' San Francisco. Price, $3.

The eighteenth edition of the late Professor Jamieson's book on steam and steam-engines has been enlarged to two volumes and deals with internal-combustion as well as steam engines. Volume I is devoted entirely to the reciprocating engine, while Volume II will discuss steam-boilers, steam-turbines, and internal-combustion engines. The book has been thoroughly revised and brought up-to-date, at least from a British standpoint, although the American railroad-man may be inclined to smile a little at the description of an especially heavy locomotive, weighing 108 tons with the tender, and with 1772 sq. ft. of heating surface. The 26 chapters of the book consider the development of the steam-engine from its earliest form, give the laws of heat as applied to its construction, and then discuss the various types of reciprocating engines now in use, together with pumps and other auxiliary machinery. The book is well illustrated. It will be of value as a text-book, although most American instructors will probably prefer some one of the other standard books more directly related to American practice, which, while agreeing in the main points with British practice, nevertheless differ in details.

Foundry Practice. By R. H. Palmer. Second edition. Pp. 377, ill., index. John Wiley & Sons, Inc., New York. Price, $3.

In preparing the second edition, the book has been revised and some new material added, principally about methods of making particular types of castings. The first part of the book deals with molding, commencing with the simpler kinds of castings and proceeding to the discussion of the more complex. There are special chapters on gates, risers, and feeding-heads. Cleaning and mending castings are also discussed. A chapter is devoted to molding-machines. Other chapters discuss iron and its composition, the cupola, the air-furnace, the brass foundry, and foundry equipment. There is a glossary and an appendix containing mathematical and other tables. The book will be useful not only to the student and the apprentice, but also to the experienced molder.

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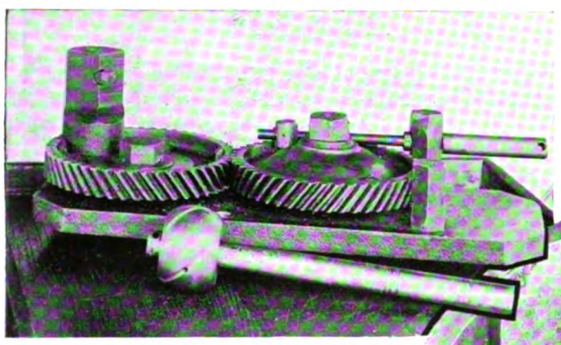
INDUSTRIAL EQUIPMENT

AUTOMOBILE TURNTABLE

The storing of a number of cars in a limited space, particularly in a large public garage, brings with it the problem of getting these cars in and out of the garage quickly and safely. With the ordinary equipment, and with a number of people wishing to move their cars at the same time,

Turntable for Garage

there is a great deal of delay and inconvenience, and occasionally some collisions that cause damage both to machines and to tempers. The Canton Foundry & Machine Co., of Canton, Ohio, has developed a turntable, as shown in the



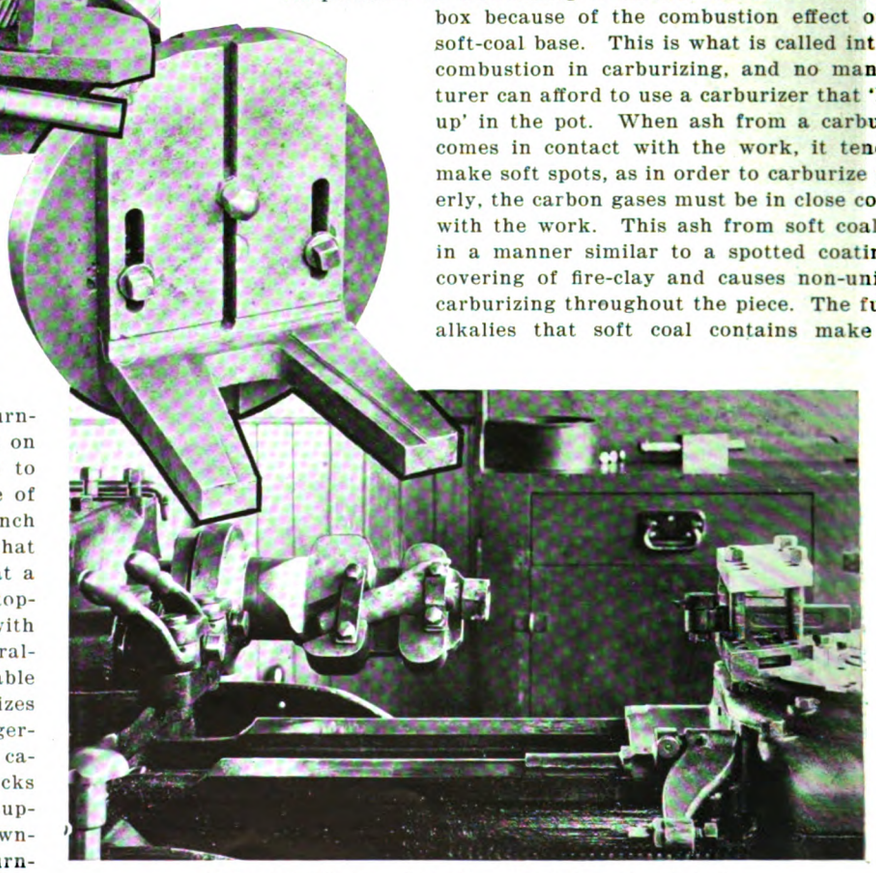
accompanying illustration, that solves this problem. A car can be run on this table, the table revolved to the proper position, and the car run off the table to its place, in much less time than by the old way. Again, a car can be placed on this table before being cleaned, and the cleaning facilitated by the ease of turning the car so as to throw the light on any part. The centre casting is 5 to 6 ft. diam., depending upon the size of the table, and contains 84 two-inch balls. The ball-race is designed so that the load rests on only a few balls at a time, minimizing the friction. The top-plates are of $\frac{3}{16}$-in. steel, reinforced with angle-iron, and resting on structural-steel trusses. The plates are adjustable to allow for wear. It is made in sizes from 12 to 16 ft. diam., for passenger-cars, all sizes having a supporting capacity of 8000 lb. The tables for trucks are 16 and 18 ft. diam. and have a supporting capacity of 8 to 10 tons. Owners of private garages also find the turntable of advantage.

SPECIAL DEVICES FOR REPAIRING MOTOR TRUCKS

The group of illustrations on this page show three devices designed by Mr. Penfield, superintendent of the truck-repair department of the Associated Oil Co. The top picture shows a tool-holder which is bolted to the tool-part and used for turning a sphere. The spiral gears are turned by a screw. Back-lash is eliminated and the tool travels steadily forward and does not dig in when it passes the centre or a high spot. In front of the tool-holder is the piece that is turned. It is held on an expanding mandrel. The centre picture is a face-plate attachment used for boring the wrist-pin holes in pistons on a lathe. The piston is slipped in on the V-shaped track on the angle-plate. The attachment is adjustable on the face-plate so that any size piston can be centred. The nut in the centre is used to steady the work, and the piston is fastened to the device by clamps, which are not shown. The bottom picture shows a chuck for brass hose-couplings, which are used in large quantities on the company's tank-wagons.

BITUMINOUS COAL AS A BASE FOR CARBURIZING COMPOUNDS

Bituminous coal is sometimes used as the base of carburizing compounds but several disadvantages have tended to discourage its use. Coal is not uniform in its composition, as the proportion of carbon and ash varies, and, in addition, an appreciable amount of fusible alkalies is found. These are the sodium and potassium alkalies that go to make up the glass-like blebs frequently noticed by users of coal-base carburizers. The non-uniform carbon content, the large proportion of ash and the fusible alkalies are three things which are detrimental to successful carburizing. As a result of non-uniform carbon content, the carburizer made from a soft-coal base, has a tendency to increase the temperature inside the box, and so it is found that the applied temperature in carburizing is further increased inside the box because of the combustion effect of the soft-coal base. This is what is called internal combustion in carburizing, and no manufacturer can afford to use a carburizer that 'heats up' in the pot. When ash from a carburizer comes in contact with the work, it tends to make soft spots, as in order to carburize properly, the carbon gases must be in close contact with the work. This ash from soft coal acts in a manner similar to a spotted coating or covering of fire-clay and causes non-uniform carburizing throughout the piece. The fusible alkalies that soft coal contains make tiny



Devices for Motor-Truck Repairs. (See text for description)

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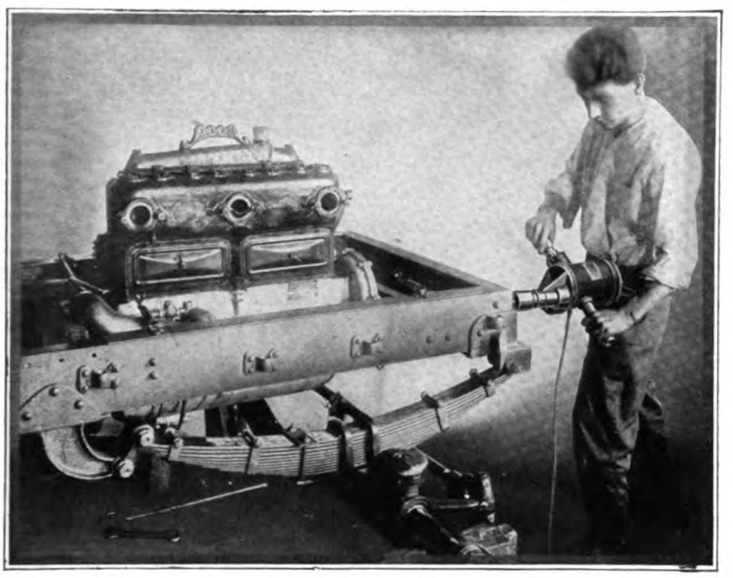
glassy blebs, which stick to the work, and the compound does not come free from the piece when it is unpacked from the pot. These blebs usually have to be knocked off, and sometimes a cold chisel is needed to remove them. This condition has been overcome by mixing lime with some soft-coal carburizers, but if the mixture is not uniform, these glass-like blebs will be found on the work. The heating-up in the box results in uncertain carburizing; ash causes non-uniform penetration, while glass-like blebs are detrimental to threads if it is desired to harden them and keep them standard.

ELECTRIC DRILL

The Standard Electric Tool Co. of Cincinnati, Ohio, manufactures a portable electric drill which is practically fool-proof. It is built on the unit plan and consists of five simple units, which can be easily taken apart without disturbing any electrical connections. The tool is rigid and simple although not heavy. The metal is so distributed as to give unusual strength where the strains are the greatest.



Portable Electric Drill

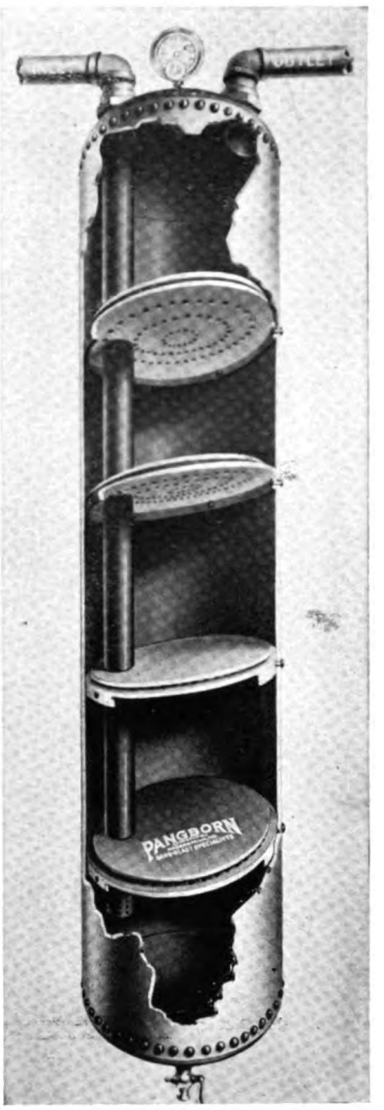
Cooling is done by an improved method of forced ventilation. A fan of circular design is placed on the armature-shaft, which expels the warm air and replaces it with cool air. Series motors are used as the experience of the company goes to show that this type of motor is far superior for electric-drill work. The armature spindles run on ball-bearings and in sizes from $\frac{3}{8}$ to $1\frac{1}{4}$ in. The shears are also mounted on ball-bearings. The bearings are packed in heavy grease. No thin oil is used except on chuck and sprocket spindles so that danger of oil-soaked motor insulation is eliminated. The drills are sold under a factory guaranty of one year. Breast-plates or old-man attachments can be furnished when desired.

THE PANGBORN MOISTURE AND OIL SEPARATOR

Moisture in compressed air is a detriment at all times. With a saturated atmosphere some dependable means for eliminating moisture, or at least reducing it to a minimum, is a necessity. On account of constant condensation, a single device on extended lines does not give desired results at the tool itself and the most satisfactory arrangement is a smaller unit at each branch line.

The moisture and oil separator illustrated here has been used with much success in the East for a number of years and will be welcomed by the Coast foundryman. The mechanical operation of separating the moisture from the air is based upon the fact that when air at high pressure and velocity is compelled to make an abrupt change of direction, the heavier particles containing the moisture, by their momentum, will strike the walls of the apparatus in which this change of direction takes place. This causes a compression of the particles of air, which tends to separate the moisture and to deposit it upon the walls of the vessel. The separator consists of a steel tank, containing a series of perforated-shield and solid baffle-plates, and an internal piping arrangement.

The air enters through the inlet-pipe, which extends down



Moisture and Oil Separator

through the plate to a few inches from the bottom of the air-chamber. This pipe is closed at the lower end. There are small holes around the circumference near the base, through which the air is expelled in small jets against the walls of the air-chamber. It then percolates through and around the plates to the outlet-pipe, where it is delivered to the tools free from moisture. By the use of a number of these baffle-plates increased separation efficiency is secured. They are so proportioned that there is less than 1% loss of pressure in passing through the separator. These baffle-plates incline toward the inlet and, in conjunction with the perforated-shield plates, divide the incoming air into a number of streams, which strike the baffle-plates and deposit thereon the moisture the air carries. By this contact with the

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baffle-plates, the air is deflected and caused to strike against the sides of the air-chamber. Lubricating-oil from the compressor that is carried into the air-line, and which is so destructive to rubber hose, is separated from the air, and the life of the hose is lengthened materially. The slope of the plates allows the adhering moisture and oil to collect in the bottom of the air-separator, from which it is drawn off through the drain-cock.

The separator is manufactured by the Pangborn Corporation, Hagerstown, Maryland, and is distributed by Ditty Bros., Inc., San Francisco and Seattle. It is made in eight sizes with connections for lines 1 to 3 in. diameter.

CRANE FOR BRASS-FOUNDRIES

A crane especially designed for use in the brass-foundry has been developed by the Whiting Foundry Co. The illustration shows the application of the crane to the handling of crucibles. The Whiting Foundry Co. is represented on the Pacific Coast by Eccles & Smith, of San Francisco, Los Angeles, and Portland, and by W. H. Hendry & Co., of Seattle.

Crane for Handling Crucibles

DRILL-VISE

In order to save the trouble and expense of making expensive drilling jigs on many classes of work, the Graham Manufacturing Co., of Providence, Rhode Island, has developed a drill-vise with jig-attachments as shown in Fig. 1.

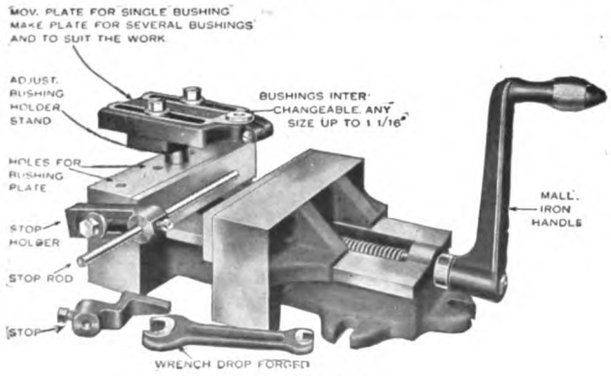


Fig. 1. Drill-Vise

This vise will hold work for drilling in the same way as an ordinary drill-vise, and in addition will hold it so that duplicate parts may be clamped in exactly the same position each time. Furthermore, the jig attachment permits the drilling of each piece as well as if a special jig were used.

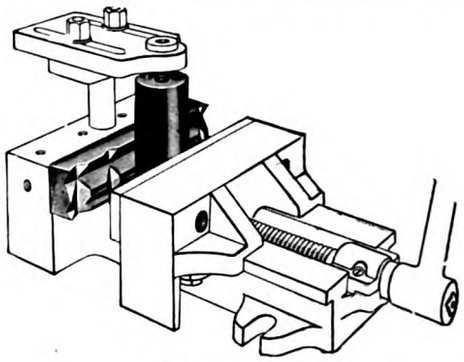
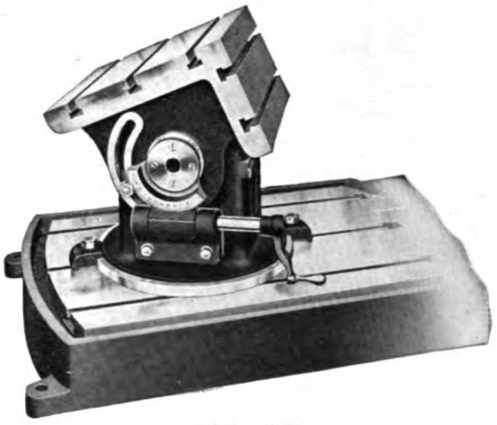


Fig. 2. V-Jaw Attachment

Fig. 2 shows the V-jaw in place for holding round work in either a vertical or a horizontal position. The drill-bushing and holding-plate are shown in outline.

THE MORRIS TILTING TABLE

The tilting table shown in the illustration is manufactured by the Morris Machine Tool Co. for use with its radial drills. The table can be tilted at any angle by means of a worm and worm-wheel segment, the latter being graduated in degrees. The table can also be swiveled and clamped in any position. When the table is brought to the straight position it rests on positive stops. The table used with the 2½, 3, and 3½-ft. drills has a top working-surface 18 by 18 in. and a side working-surface 11 by 18 in. For the 4 and 4½-ft. drills the working-surfaces are 18 by 24 in. and 11 by 24 in., respectively. The table is handled on the Pacific Coast by the Pratt & Whitney Company.



Tilting Table

MALLEABLE CAPACITY IDLE

In connection with the insistent demand for malleable castings, the American Malleable Castings Association reports that this demand has been anticipated, and that ample facilities have been provided for both the present and future expansion of the industry. It is stated, however, that at the present time the shortage of unskilled labor will not permit this capacity being used. Fully 200,000 tons of malleable capacity is today idle but would be immediately available if the necessary labor could be secured. Improvement in this direction is not expected until the activities of other industries are curtailed, or until there is a flow of im-

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migration sufficient to build up the supply of labor available for foundry work. This means, therefore, a large proportion of capacity idle continuously in every plant regardless of heavy unfilled orders.

DRILL-SPEEDER

In order to get the maximum capacity from large drill-presses, the Graham Manufacturing Co., of Providence,

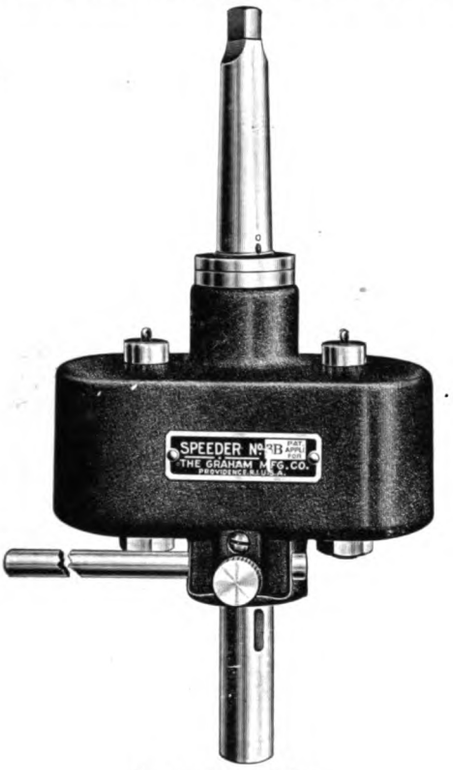


Fig. 1. Drill-Speeder

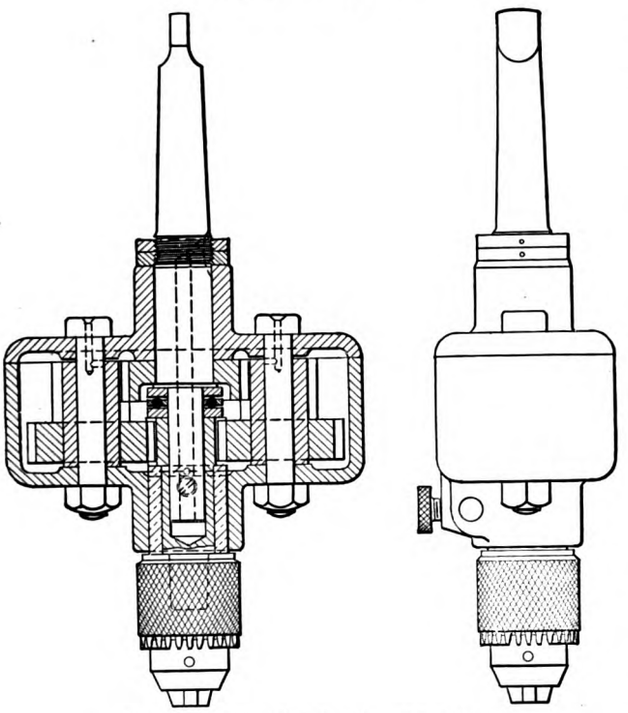
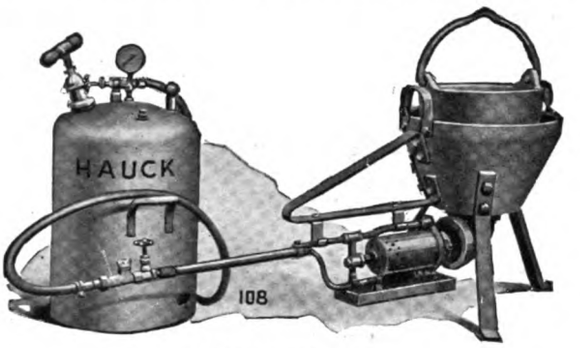


Fig. 2. Internal Construction of Speeder

Rhode Island, has developed a drill-speeder, as shown in Fig. 1, which makes it possible to drive small drills at the proper speed, even when used in large drill-presses. The speeder is designed to give three revolutions of the drill to one of the shank. Fig. 2 shows the internal construction. The shank is made of tool-steel with tip hardened. On the bottom is fastened a casehardened gear, which meshes on two pinions mounted on casehardened studs. On these pinions are fastened a pair of large gears, which mesh into the spindle-pinion from opposite sides. The pinion and spindle are made of one piece of hardened tool-steel.

THE HAUCK LEAD-MELTING FURNACE

The combination lead-melting furnace and portable oil-burner shown in the illustration is a useful device for the machine-shop. Using it as a melting furnace, 200 lb. of lead or babbitt can be melted in 15 minutes and can be kept in molten condition at a cost of a few cents per hour. When not



Lead-Melting Furnace

used for melting lead in the pot, the burner may be detached from the furnace and used for melting babbitt from bearings, re-babbitting, bending pipes, straightening, preheating in connection with welding, brazing, expanding to make shrink-fits, and similar work. The device consists of a furnace on three legs, supplied with a 200-lb. capacity pot. The 12-gallon oil tank is of heavy steel, equipped with pressure gauge, hand-pump, and fittings. The burner is of the Hauck hand-pump type, using kerosene as fuel. The burner does not consume any air from the tank. The pressure furnished by the pump is used simply to force the oil to the burner, where it is vaporized. A single pumping will operate the apparatus for three hours. The equipment is handled by Harron, Rickard & McCone, of San Francisco and Los Angeles.

NEW EXPRESS PACKING-RULES

New express packing-rules will go into effect on December 10, and shippers are requested to prepare themselves for the new standards. The new packing requirements, which were recently approved by the United States Railroad Administration, were formulated to provide additional safeguards for merchandise sent by express. Heretofore, shippers have been using all sorts of containers for express packages. The new rules will not permit the use of paper wrapping for packages over 25 lb., nor of ordinary paper boxes, wrapped or unwrapped, when the weight of the package is over that limit. For shipments over 25 lb., wooden containers, or containers of fibre-board, pulp-board, or corrugated strawboard material are required. The cartons must be made of materials of specified 'test strengths', similar to those required for the freight service, and the containers must bear the stamp of the manufacturers certifying that the material used is of strength required for the weight of the shipment carried in it, as provided in the rules. The express regulations, though modeled on those for freight movement, permit a wider latitude in the size of the carton used, and carry a certain number of exceptions.

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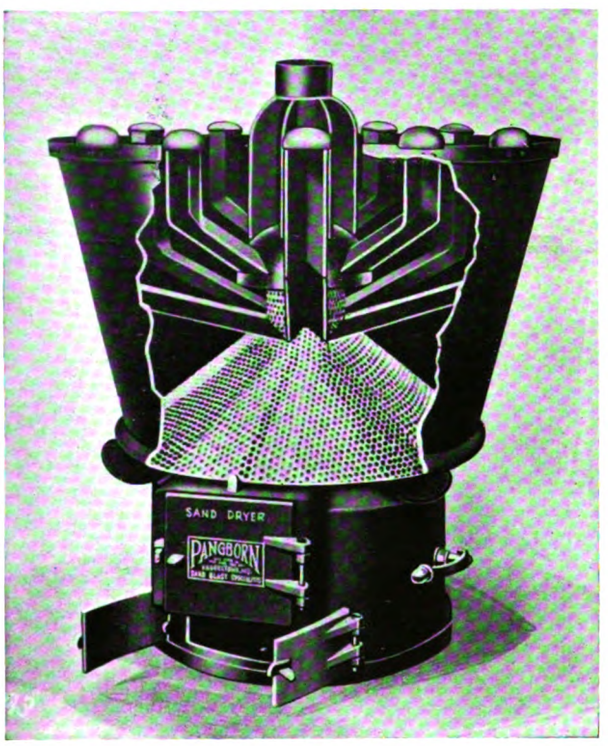
Shippers who wish to acquaint themselves with the new express regulations are requested to study Supplement No. 5 to Express Classification No. 26, in which these rules are embodied, copies of which may be secured at any express office.

THE PANGBORN TYPE DC SAND-DRYER

The economy as well as the added abrasive efficiency of dry sand in sand-blast work is so well known that the foundry that does not have a sand-dryer among its equipment can hardly be considered working to best advantage. Quick drying is obtained by the constant circulation of the heated air through the mass of the sand. Burning or calcining the sand has been prevented by maintaining an air-space between the stove and the sand-hopper. Radial arms or flues, open on the under side, circulate the hot air in all directions through the mass of sand, concentrating and carrying off the moisture with great rapidity, which prevents 'packing' and 'arching', and keeps the wet sand always on the screen until it becomes thoroughly dry, drops through the perforations, and runs down the inclined surface of the



The Pangborn Sand-Dryer

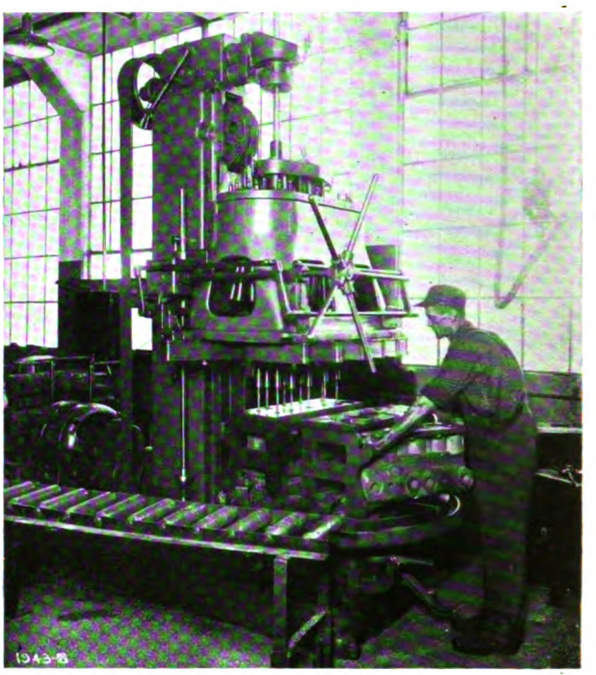
fire-box to the floor. The inside of the fire-box is constructed with a series of concentric rings projecting toward the fire, which distribute the heat evenly under the perforated screen, and ensure fuel economy.

As the sand, until dried thoroughly, is at all times supported away from the fire-box with air-space between it and the perforated screen, burning is impossible even with the fire-box at red heat. Small doors in the hopper allow for removing material that may get into the hopper and will not easily pass through the perforations of the screen.

The dryer is adaptable for use with coal, coke, or wood, and can, if required, be equipped for burning oil or gas. It is made in two sizes, with sand-holding capacities of 1000 and 2000 lb., and drying capacities per hour for sands free from loam and clay, and with not exceeding 15% moisture, of 500 and 1000 lb., respectively. It is manufactured by the Pangborn Corporation, Hagerstown, Marlyland, and distributed by Ditty Brothers, Inc., San Francisco and Seattle.

'NATCO' ROTATING TABLES

The economical use of multiple-spindle drilling machines is dependent upon their being kept busy. In particular, there should be no delays while the operator is setting up work. To accomplish this end, the National Automatic Tool Co., of Richmond, Indiana, has developed a rotating table for use with the company's multiple drills, which en-



Rotating Table

ables the operator to load and unload one set of work while the machine is working on another. The table is particularly useful for drilling, for drilling and reaming, and for drilling, reaming, spot-facing, or counter-boring, which is made possible by passing the piece from one position to another without re-jigging. The tables are regularly indexed for 90°, 120°, and 180°, which permits one, two, or three distinct operations to be performed at the same time. The tables are built in three sizes, 34 in. and 44 in. diam. by 16 in. high for the larger machines, and 22 in. diam. by 5½ in. high for the smaller drills with table-feed, or with an adjustable table. The illustration shows a 44-in. table used for drilling cast-iron cylinder blocks at the Buda Co. plant at Harvey, Illinois. All tables are hand-operated, as this type is quicker to operate, less complicated, and gives greater production than when power-feed is used. Drains are provided for carrying off the lubricant. If the table is not needed on a certain job, it can readily be removed from the machine.

BURNER FOR QUICK-REPAIR WORK IN THE SHOP

The hand-pump burner shown in the illustration has proved one of the easiest, most economical, and practical means of heating, particularly for pre-heating before welding, brazing, expanding to make shrink-fits, straightening, forging, tempering, and melting babbitt out of bearings. On pre-heating work by using a cheaper fuel to heat the metal, the entire efficiency of the welding flame is used for welding alone. This means a saving of 50% in the consumption of acetylene and gas, and a corresponding saving in the cost in time and labor. Pre-heating with this type of burner permits welding to be done in place without dismantling.

The burner uses kerosene and produces an intense blue flame without smoke or soot, easily regulated and always

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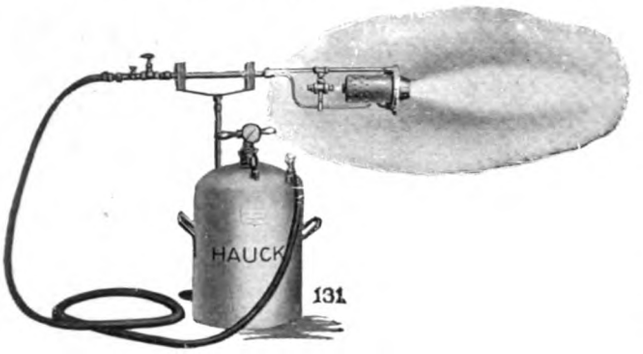
under the control of the operator. The hand-pump on the tank gives from 30 to 60 lb. pressure. One pumping operates the burner for three hours. The apparatus is supplied

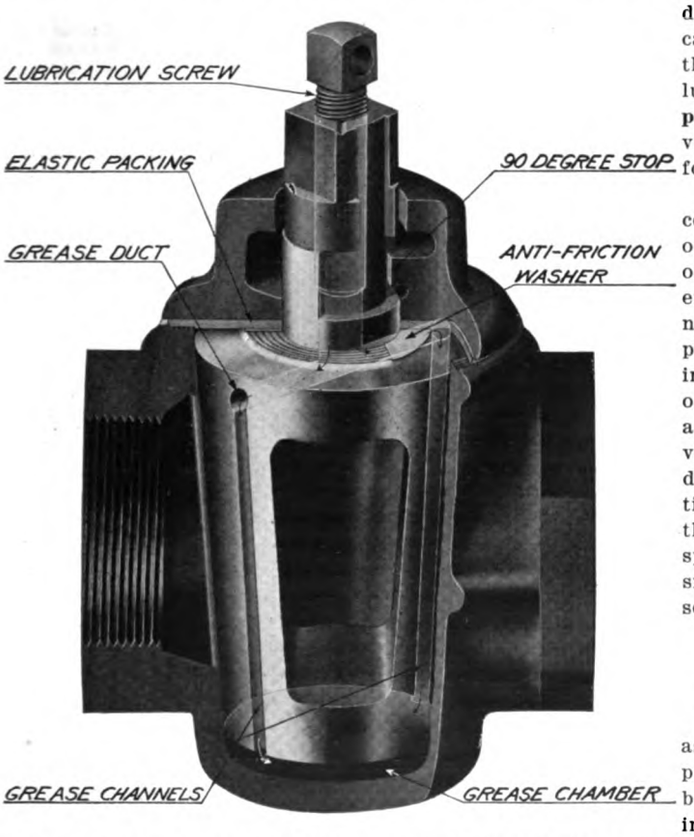


The Hauck Burner

with pressure-gauge, oil-regulating valve, and 12 ft. of special oil-resisting hose. The small five-gallon size has a handle on the tank so that a man can carry it easily. The device is handled by Harron, Rickard & McCone, of San Francisco and Los Angeles.

A LUBRICATED PLUG-VALVE

Standard plug-cocks and gate-valves on pipe-lines in mills, cyanide plants, and other works, are frequently the cause of much bother from becoming 'frozen', followed by their being broken. This happens in spite of grease and cleaning, and we have known of large plants where one



man was kept busy doing this. Accompanying these notes is a diagrammatic view of a new, though thoroughly tested, plug-valve, the invention of S. J. Nordstrom, who was engaged in the design, construction, and operation of cyanide plants in Mexico. For over three years this valve has been in use, particularly at Pachuca and El Oro. It has also been adopted as standard equipment at several plants in place of ordinary plug-cocks and gate-valves for cyanide solutions, slime, water, and air.

The basic principle of the Nordstrom patent is the combination in a plug-valve of lubricant conduits and a lubricant chamber at the base of the plug so positioned that when pressure is applied to the lubrication screw, this pressure operates to lift the plug from its seat and simultaneously to distribute lubricant over the bearing surfaces. A flexible packing is provided between the body of the valve and the cover. This packing also rests upon an anti-friction washer forming the thrust bearing of the plug. This thrust bearing is grooved concentrically to prevent leakage. The flexible packing furnishes the necessary elasticity to allow the plug to be forced from its seat for the purposes of lubrication and to force the plug back into its seat when the pressure in the lubricant chamber is released. The position of the lubricating conduits and of the lubricant chamber are clearly shown in the illustration. A stop is cast as an integral part of the plug and cover and is so positioned that the lubricant conduits can never be exposed to the fluid passing through the valve. From the construction it will be evident that no matter how firmly the plug may be stuck to the body of the valve, when force is applied to the lubricating screw, a pressure is created in the grease-chamber at the base of the plug, and that this pressure must either raise the plug from its seat or else break the body of the valve. For greater convenience in assembling the valve, the cover-bolts are provided with slotted lugs and a special nut is used to prevent the bolts from slipping when tightened.

Suitable lubricants are supplied in the form of convenient cartridges, which fit loosely into the lubricant conduit when the screw is removed. Several grades of lubricant are supplied to suit the special conditions under which the valves may be used. For general purposes, the No. 1 lubricant will be found satisfactory, but **The Merrill Company** of San Francisco, part controllers of the patent, advises that its special lubricants should be used as directed for certain kinds of service.

An inspection of the various makes of standard plug-cocks, now on the market, will reveal the fact that the area of the opening in the plug is frequently no more than 60% of the area of the pipe. In other words, in many cases the effective area of a 3-in. plug-cock will only be equal to the nominal area of a 2½-in. pipe. All types of the Nordstrom plug-valve are so designed as to provide a full 100% opening in the plug. These plug-valves are made with a parallel opening through the plug to minimize the friction of flow and to increase the life of the valve. The flanged type of valve is constructed along lines that ensure a high hydraulic efficiency, and the firm recommends this type particularly where such efficiency is an object. The shank of the plug of all Nordstrom valves is finished and, when specified, wrenches will be provided. These wrenches fit snugly on the head and are held in place by means of a set-screw.

COMMON SENSE OF BELTING ECONOMY*

*Edw. R. Ladew Co., Inc., Glen Cove, New York.

Economy in belting, using the term in its correct sense as covering the minimum cost of belting per horse-power per year, lies in three things: first, in selecting the proper belt; second, in properly installing it; third, in properly caring for it. More belting is destroyed by neglect and abuse than by legitimate service. A heavy belting expense is chargeable to carelessness.

1. Don't overload your belts. You thereby sacrifice your factor of belting safety and run your belts close to the limit of endurance all the time.

2. Don't put your belts on too tight. An excessive initial tension puts the belt under a strain that takes up its elastic-

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ity and shortens its life. Moreover, it puts side pressure on the bearings, which increases the bearing friction and lowers the efficiency of the drive, wastes power, and increases wear.

3. Whenever possible, machinery and shafting should be so arranged that belts run off each shaft in opposite directions, thus equalizing the strain on the bearings and minimizing bearing friction and wear.

4. Place pulleys as close as possible to hangers or other bearings, thus minimizing shaft-flexure.

5. Place belts running in opposite directions as close together as possible, and separate those running in the same direction.

6. The best distance from centre to centre of shafts, for average conditions, is 20 to 25 feet.

7. The angle between the belt and the floor should not be more than 45°.

8. Pulley-diameters should be as large as possible, provided the resultant belt speed does not exceed 6000 ft. per minute.

9. The direction of drive should be such as to put the slack side of the belt uppermost, thus securing the largest contact areas on the pulleys and the maximum pull. In other words, the belt should travel from the top of the driving pulley to the top of the driven pulley.

10. Belt-tighteners should be on the slack side of the belt and near to the smaller pulley. But the idler should not be so small nor so close to the smaller pulley as to make a sharp turn in the belt, which would tend to strain the laps.

11. Belts put on endless (cemented joint) are always to be preferred, especially where the speed is high.

12. When it is not possible or convenient to make a belt endless, wire lace is recommended as the best means of joining the ends.

13. Pulleys should be a little wider than the belt and the direction of belt travel should be with the belt laps, not against them.

14. Pulleys crowned too high cause the belt to flap on the slack-side, reduce the arc of contact on the edges of the belt, strain the centre sections of the belt, and tend to make the belt run off when heavy load is encountered.

15. Be sure the shafts are in line, and are kept in line. Otherwise the belts are under unequal tension on their two edges and will run off.

16. Belts should be run with the grain-side next to the pulleys. Not only does the smooth grain-side adhere more closely to the pulley, but the flesh-side, being stronger than the grain-side, is better able to stand the stretching going around the pulleys while the grain-side is best able to stand crimping. Tests show a gain of about 30% in driving power in favor of the grain-side next the pulley.

17. Covering the pulleys with high-grade leather will increase the driving power about 25%, due to the greater adhesion of leather on leather. Higher transmission efficiency is secured because the belt need not run so tight to prevent slipping, and journal friction is reduced.

18. Do not permit lubricating oil to get on the belt. It injures the grain, weakens the fibre, and shortens the life of the belt.

19. The application of resin, tar, or similar substances to prevent slipping is false economy and shortens the life of the belt.

20. A belt needs internal lubrication—lubrication between its fibres—to give the longest and most efficient service.

21. Don't expect good service and long life from a non-waterproof belt run in the presence of moisture, steam, oil, or acid fumes.

22. Your belting equipment is an investment. Give it the care and attention any legitimate investment deserves. Don't put it in charge of an unskilled man. Make the care of your belting some one intelligent man's business and hold him responsible for the condition of the belts and for freedom from interruptions and losses due to belt failure or trouble.

23. No one knows just what is the life of a good leather belt well cared for. Even after it has become unfitted for its original purpose, it may still be cut into narrower widths for other purposes or put on lighter work. What you get out of a good leather belt depends upon how much intelligent care you give it.

The following rules for belt calculations are also given by the Ladew company:

To Calculate the Length of a Belt: Add together the diameters of the two pulleys, in inches; multiply the sum by 3.1416; divide the result by 2; reduce to feet by dividing by 12; add twice the distance in feet between pulley centres; the sum is the length of the belt in feet. Do not give short measurements in ordering and then attempt to force the belt over the pulleys. The extra strain on the point where the belt is forced will produce a distorted section and invariably result in a crooked belt. Be generous, rather than scant, in your measurements.

To Calculate Size and Speed of Pulleys: Rule A—To find the speed of the driven pulley in r.p.m., multiply the diameter of the driving pulley by its speed in r.p.m. and divide by the diameter of the driven pulley.

Rule B—To find the speed of the driving pulley in r.p.m., multiply the diameter of the driven pulley by its speed in r.p.m. and divide the diameter of the driving pulley.

Rule C—To find the diameter of the driven pulley, multiply the diameter of the driving pulley by its speed in r.p.m. and divide by the speed in r,p.m. of the driven pulley.

Rule D—To find the diameter of the driving pulley, multiply the diameter of the driven pulley by the speed sought in r.p.m. and divide by the speed in r.p.m. of the driving pulley.

To Calculate the Speed of a Belt: Multiply the diameter of the pulley in inches, by 3.1416. Divide by 12 and multiply by the speed of the pulley in r.p.m. The result will be the belt speed in feet per minute.

To Calculate the Horse-Power of a Leather Belt: Multiply the speed of the belt in feet per minute by its width in inches. For single belts, multiply this product by 50; for double belts by 80; and for three-ply belts by 100. Divide by 33,000 and the result will be the horse-power that can safely be transmitted by the belt at that speed.

To Calculate the Width of a Leather Belt: Multiply the horse-power to be transmitted by 33,000. For single belts, divide this by 50 times the speed of the belt in feet per minute; for double belts, divide by 80 times the belt speed; for three-ply belts, divide by 100 times the belt speed. The result is the width of the required belt in inches.

To Calculate the Arc of Contact of a Belt on the Smaller Pulley: Divide the difference between the diameters of the larger and smaller pulley by the distance between centres of shafts; multiply this by 57; subtract from 180. This gives the arc of contact in degrees.

Multiply the circumference of the smaller pulley, in feet, by the number of degrees of arc of contact determined as above; divide by 360. The result is the arc of belt-contact on the smaller pulley, in feet.

To Calculate the Length of a Crossed Belt: Find the length of the straight belt for equal pulley sizes and centres by the rule already given. Square the diameter of the large pulley; square the distance between centres; add together and extract the square root of the sum; subtract from this the distance between centres; multiply by 2; add the length of straight belt previously found.

A. G. Linz and **Fred Bowman** have opened a repair shop for general machine work at Los Gatos.

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TRADE NOTES

The Colusa Machine Shop, Colusa, is being enlarged.

Jesse R. Bledsoe will open a machine-shop at Tulare.

The Norway Pacific Construction& Drydock Co., of Seattle, will build a 20,000-ton floating drydock at its plant.

B. C. Manby has opened a machine and general repair shop at Auburn.

The Cruss Air Spring Co., 175 Grove street, San Francisco, is buying new machinery.

Plans have been completed for a $125,000 office-building for the **Main Iron Works,** San Francisco.

A bond issue of $3,064,000 was voted at Sacramento on October 18 for the construction of school-buildings.

J. Ray McKinney and **C. J. Johnson** will start a foundry at Woodburn, Oregon, and have leased the old Woodburn Foundry building.

The Burns Machine Works, Pendleton, Oregon, has been incorporated with a capital of $25,000, by W. J. Burns, Ina Burns, and R. J. Warner.

The Edward Rutledge Timber Co., of Spokane, will erect a large modern sawmill at Coeur d'Alene, Idaho, duplicating its present plant at that city.

S. N. Griffith will construct a six-story reinforced concrete hotel building at M and Mariposa streets, Fresno. The estimated cost is $400,000.

Wright & Hengst have purchased the repair and machine department of the Lemoore Garage, Lemoore, and are making additions and improvements.

The Pacific Forge & Iron Co. has let a contract for the erection of a 100 by 100-ft. building at the corner of Arkansas and Seventh streets, San Francisco.

The Western Milling Co., of Oakland, has purchased a tract of land on the tidal canal at Fruitvale and will construct a grain-elevator and milling plant.

The directors of the **Kellar-Thomason-Fleming Co.,** of Fresno, have petitioned for the right to change the company name to the **Martin-Fresno Iron Works.**

Crow & Goode, who have been conducting a blacksmith shop at Fortuna, have bought out the interests of the former proprietors of the **Fortuna Machine Shop.**

Charles Piez, president of the **Link-Belt Co.,** and formerly head of the Emergency Fleet Corporation, has been making a tour of the principal cities of the Pacific Coast.

The Keystone Iron & Steel Works, Los Angeles, recently signed a contract for the erection of a foundry building at 37th street and Vernon avenue, Vernon, for $71,600.

The Berger & Carter Co. has moved its executive offices to the fourth floor of the Fremont building, where all department of the business will be controlled in the future.

The Interstate Warehouse Co. has been incorporated for $100,000, and plans to build at Caldwell, Idaho, a 60,000-bushel grain elevator and a 100,000-bushel storage warehouse.

The Commercial Metal & Machinery Co. has sold a 150-ton hydraulic car-wheel press, made by the Lourie Manufacturing Co., to the city of San Francisco, for use on the Hetch-Hetchy project.

J. W. and **P. E. Wright** have established a foundry at Anacortes, Washington. They are equipped for making iron, steel, and brass castings, and will specialize on marine and mill work.

The Barrett Steel & Wire Co., of San Francisco, has been incorporated with a capital of $100,000. The directors are W. J. Barrett, H. F. Davis, G. W. Murphy, Helene A. Scott, and W. D. L. Fitch.

The machine shop operated by **Zacker Bros.** at Lodi, was recently sold to Messrs. Ebel, Rudloff, Ebel, and Diehl, and the business is now being conducted under the name of **Ebel, Rudolff & Ebel.**

General farm implements are to be produced by the **Spear-Wells Machinery Co.,** which has purchased property at the corner of Ninth and Cedar streets, Oakland, and begun improvements at a cost of $50,000.

The J. Paulding Edwards Co. has leased a tract of land on Harrison avenue near Park street, Alameda. Shops and laboratories for aeronautical and marine designing, construction, and repair will be built.

A contract for building a sugar-mill in the Philippines for the **Azugero Delacarlota Co.,** having a capacity of 1000 tons per day and costing approximately $1,000,000, has been awarded to the **Honolulu Iron Works.**

The California Metal Works, of Oakland, owned by Anton Weber, William E. Leibing, and Mrs. Olga Weber, has been ordered dissolved by Superior Judge T. W. Harris, in accordance with the voluntary application of the directors.

The San Joaquin Light & Power Corporation has applied to the State Railroad Commission for permission to issue $3,248,000 in bonds to provide funds for completing the Kerckhoff hydro-electric project on the San Joaquin river.

Contract for building ten steel cargo vessels for the Emergency Fleet Corporation has been awarded to the **Southwestern Shipbuilding Co.,** acting in conjunction with the **Western Pipe & Steel Co.** The total cost is about $20,000,000.

The Globe Milling Co. has increased its holdings at Stockton and now owns a frontage of 1400 ft. along the Stockton channel. As soon as the work of filling the site has been completed, construction will be commenced on a $1,000,000 flour-mill building.

The Pangborn Corporation, of Hagerstown, Maryland, has issued a 16-page illustrated pamphlet showing photographs of the various departments of the company's plants, of its executive and sales force, and of typical installations of its sand-blast machinery in various plants.

The general contract for the construction of the new administration building for the University of Southern California at Los Angeles has been awarded to **Edward C. English** for about $400,000. Contract for the steel work was awarded to the **Baker Iron Works.**

The Commercial Brass Foundry is installing two additional furnaces at its foundry at 83 Natoma street. An overhead trolley will handle the hot metal. These improvements increase the capacity of the foundry to 4000 lb. per day and 1000 lb. for a single casting.

The Ewauna Box Co., Klamath Falls, Oregon, will construct a sawmill on the site adjoining its box factory. Plans call for a mill with a capacity of 80,000 ft. per day, but the difficulty of securing sufficient machinery may make it necessary to start with half that capacity.

The shipyard of the **Albina Engine & Machine Works** at Portland has been sold to the **Albina Engine & Machine Works Sales Co.** The latter concern was organized to dispose of the stock and machinery remaining at the plant at the completion of shipbuilding at the yard.

Permission to re-build the **Portland Boiler Works** at Seventeenth and Pettigrove streets, Portland, has been given by the city council. The plant was partially destroyed by fire early in September and objections made by property-owners in the neighborhood to its construction.

Deeds have been recorded conveying 300 acres of land between the Southern Pacific tracks and the plant of the Pacific Coast Shipbuilding Co., at Bay Point to the **Bay Point Shipbuilding Co.,** of which William Kent is president. The land is to be reclaimed for factory purposes.

With the floating of a bond issue of $750,000, the **Pacific**

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Tank & Pipe Co., which has large holdings along the tidal canal near the High Street bridge, Oakland, is preparing to make improvements and extensions to its plant which will enable it to dock large sea-going vessels and increase its facilities and output.

A trust deed in favor of the **Portland Trust Co.**, which has been placed on record at Bend and Klamath Falls, Oregon, secures a $10,000,000 bond issue of the Oregon, California & Eastern Railway Co. This company was promoted shortly before the War by Robert E. Strahorn to construct railroads from Bend to Klamath Falls, from Silver Lake to Lakeview, and from the latter line to Burns and Narrows.

The Haynes Stellite Co. has issued a little handbook, which gives a brief description of stellite and something of its record as a cutting tool in the production of shells for the Government during the War. Methods are described for welding and brazing stellite to a steel shank so that all the metal can be used. There are complete directions with illustrations for grinding stellite tools so as to get the best results.

The Pacific Gas & Electric Co. has established camps at the 'Big Bend' of Pit river near the site of the proposed hydro-electric plant projected by the Northern California Power Co., whose property the Pacific Gas & Electric Co. acquired recently. This is taken to indicate that the Pacific Gas & Electric Co. will commence construction on this project next year, rather than on the project it started itself just before the War.

The Best Steel Casting Co. of Oakland is installing a Pangborn Curtis type sand-blast in its new gray-iron foundry to be used for cleaning iron castings. The impression has prevailed in the past that sand-blast cleaning was suitable only for steel-casting work, but gray-iron foundrymen are finding that this method not only greatly reduces the cleaning cost, but the cleaning is also far more thorough. This equipment was purchased through **Ditty Bros., Inc.**, of San Francisco.

Hill, Hubbell & Co. of San Francisco recently placed an order with **Ditty Bros., Inc.**, for a complete Pangborn sand-blast equipment to be used in removing rust and scale from the sides of steel ships, preparatory to repainting. It is estimated that this equipment will clean ten times as much metal as a man can clean under the old hand method, and much better, as all foreign substances are removed. It is proposed to install this equipment, together with a compressor, on a barge, to be moored alongside the ship. Not only will the cost of cleaning be reduced considerably, but the saving of time is also important. This will appeal to ship owners, as every minute a ship is out of service is costly to the owners.

Catalogue No. 45, which has just been published by the **Western Wheeled Scraper Co.**, contains a detailed account of the technical side of concrete road building. This new catalogue is most attractive, being profusely illustrated with photographs showing the various stages of concrete road building work and the application of modern equipment to road construction. The catalogue also contains a discussion of the use of industrial track and haulage-ways in connection with road building. This part of the catalogue contains numerous charts and road plans showing the most efficient means of distribution of materials and the proper track schemes to be employed in this kind of work. The catalogue will be sent upon request by addressing the Western Wheeled Scraper Co., Aurora, Illinois.

The Associated Pipe Line Co. has recently installed at its plant at Sumner, California, a Pangborn sand-blast outfit, purchased through **Ditty Bros., Inc.**, of San Francisco. Approximately 4000 ft. of 8-in. pipe has already been cleaned above ground, this at the rate of 300 ft. per day with one operator. The rate used to be 30 ft. per man per day with the old method. The cleaning is more thorough, as all scale, rust, paper, etc., are entirely removed, and the new paint is applied to the clean metal. By increasing the air-pressure and using a sand better adapted to the work, it is believed that more than 300 ft. per day can be cleaned. Experiments will be made in the spring on cleaning the pipe as it lies in the ground, using the same method. The company also proposes to use the sand-blast cleaning in place of steam for cleaning the inside of oil-storage tanks.

A large drop-forge plant is to be erected in the Bay district by the **Pacific Drop Forge Co.**, whose office is at 811 Balboa Bdg., San Francisco. This company has but recently been organized with a capitalization of $500,000 and will begin work on the plant as soon as the site is selected. The plant will be capable of making drop-forgings up to 300 lb. in weight. The equipment will consist of the following board-hammers: three 800-lb., two 1200-lb., one 1600-lb., one 2000-lb., and one 3000-lb. There will also be one 10-ton, one 1200-lb., and one 4500-lb. steam-hammers. There will be a forge and press to serve each hammer. A complete die-sinking department and machine-shop will be installed. The officers of the company are Charles L. Froding, president; James F. Berry, vice-president; E. J. Lenihan, secretary and treasurer. Marston Campbell and W. F. Mackey are directors. The mechanical department will be under the direction of W. L. Millsey, who has had charge of the drop-forge plant at the Mare Island Navy Yard for the past 10 years, and before that was with several Eastern drop-forge plants. The company will manufacture a line of tools as well as do a general custom business. A large quantity of drop forgings are used in this territory and enough work is in sight to keep the plant busy.

Market Review

Decreased production caused by the steel strike has caused an increase in the price of many iron and steel products. Eastern prices toward the end of the month as compared with the average during September were as follows:

	Oct. 22	Sept.
No. 2 foundry pig, Pittsburgh	$29.40	$28.15
Southern No. 2 foundry pig, Birmingham	28.00	26.75
Billets, Pittsburgh	40.50	38.50
Sheet bars, Pittsburgh	45.00	42.00
Steel bars, Pittsburgh	2.35	2.35
Beams, Pittsburgh	2.45	2.45
Plates, Pittsburgh	2.65	2.55

It is reasonable to suppose that the advance in the semi-finished products will be reflected before long in the price of beams and bars. Locally, with the principal demand cut off on account of the metal trades strike, and the source of supply almost cut off because of the steel strike, the market may be said to be practically non-existent. With the added complication of the threatened coal and railroad strikes, producers have practically ceased entering into contracts for early delivery.

In spite of the closing of most of the foundries, the local price for cast-iron scrap remains around $42.50 per ton. The steel strike in the East has increased the demand for the products of the local mills and steel scrap is advancing, some sales being reported as high as $25 per ton.

Local prices of non-ferrous metals are as follows:

Ingot copper	22.50
No. 1 red ingot brass	18.50
No. 1 yellow ingot brass	15.00
Electrolytic zinc	10.00
Pig-lead, carloads	7.00
Electrolytic tin	54.50
Antimony	9.00

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